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BULLETINS

Nos. 444 to 463

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BULLETINS

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Nos. 444 to 463

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TH SINGLE CHAMBER SEPTIC TANK

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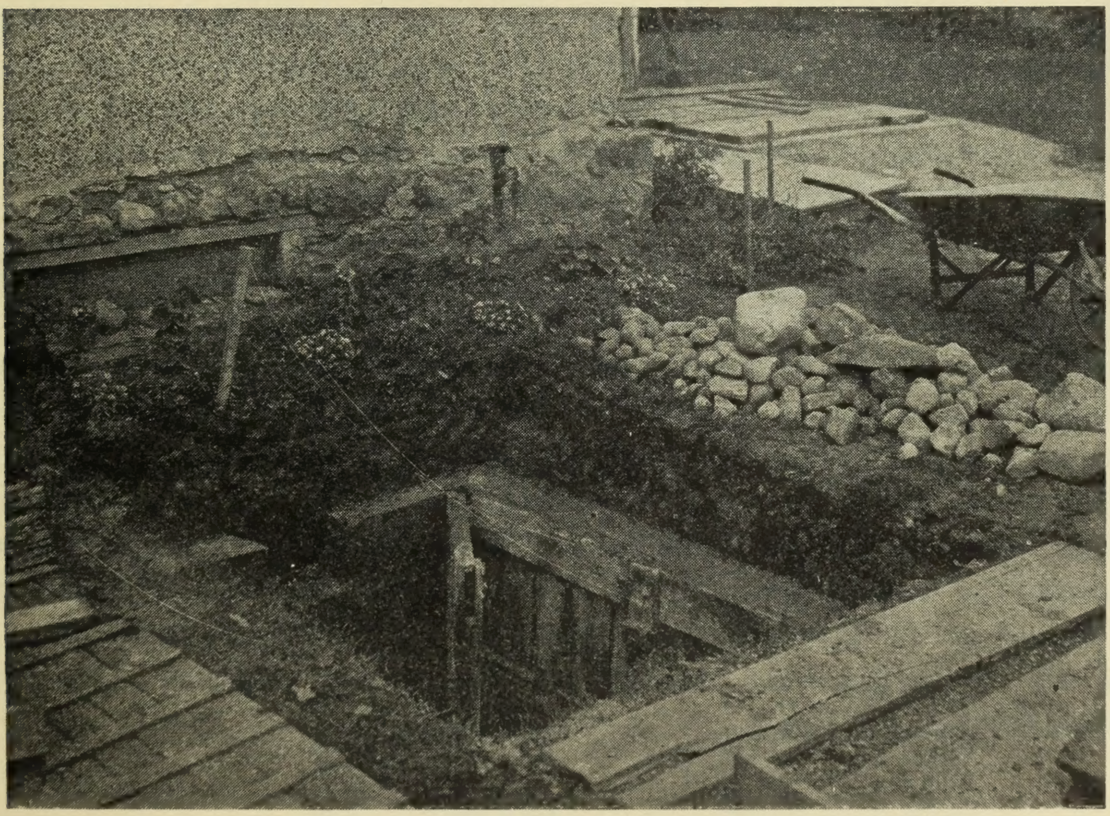
INSTRUCTIONS
FOR
INSTALLING WITH STANDARD PORTABLE FORMS
BY
THE DEPARTMENT OF AGRICULTURAL ENGINEERING
ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO



SINGLE CHAMBER SEPTIC TANK UNDER CONSTRUCTION

ONTARIO DEPARTMENT of AGRICULTURE

STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 444 • REPRINTED MAY 1947

The Septic Tank

INTRODUCTION

When the farm home is equipped with running water and a complete plumbing system, it is necessary to provide for a sewage disposal system. The approved method is the Septic Tank, which is a two-chamber, or a single-chamber tank with baffle, for receiving the sewage and holding it until digested by sewage bacteria; and a system of field tile connected thereto and laid underground for disposing of the liquid effluent discharged from the tank from time to time. For the most part the sewage is destroyed in the receiving chamber. Sewage bacteria also live in the upper layers of the soil and assist in destroying any raw sewage that may pass through the tanks into the tile. The chief products of the bacterial action in the tanks are gases and water. Disease germs may survive the action in the tank, but ultimately they succumb in the soil; and if there is plenty of soil between the absorption bed and the well there is not much chance of the water being contaminated. The sewage bacteria operating in the tanks do not require oxygen, whereas those in the soil do, and this is why the tile are laid shallow.

While there are various types of Septic Tanks, the simplest to construct is the single-chamber tank—particularly so when the ready-to-use form is available—and it is considerably cheaper. The Department of Agricultural Engineering has designed a Septic Tank of this type for farm service, and have built portable wooden forms or molds for building the tanks, and supplied these to several of the Agricultural Representatives to lend, free of charge, to farmers intending to build this tank. This special circular describes and illustrates the tank and how to use the form. The form can be transported in a motor car. If interested, telephone your Agricultural Representative, or write the Department of Agricultural Engineering, Ontario Agricultural College, Guelph, Ontario.

The Single Chamber Septic Tank

Instructions for Installing Same, Using the Portable Community Form

STEP 1.—LOCATING THE SEPTIC TANK

The preferable location for the septic tank is on the south or the most protected side of the house, since it will be warmer in the wintertime, and there will be a better bacterial action than in a colder or more exposed position. The tank itself may be located right against the cellar wall or at some convenient spot a few feet away from the house, whichever is the more convenient. Do not use the cellar wall as one wall of the tank.

The disposal tile system should *not* be put too close to the house wall, or to trees or shrubs. An open space in the vegetable garden or in an adjoining field are good locations for the tile system, and a plot of land about 30 by 30 feet is large enough to accommodate the necessary quantity of tile.

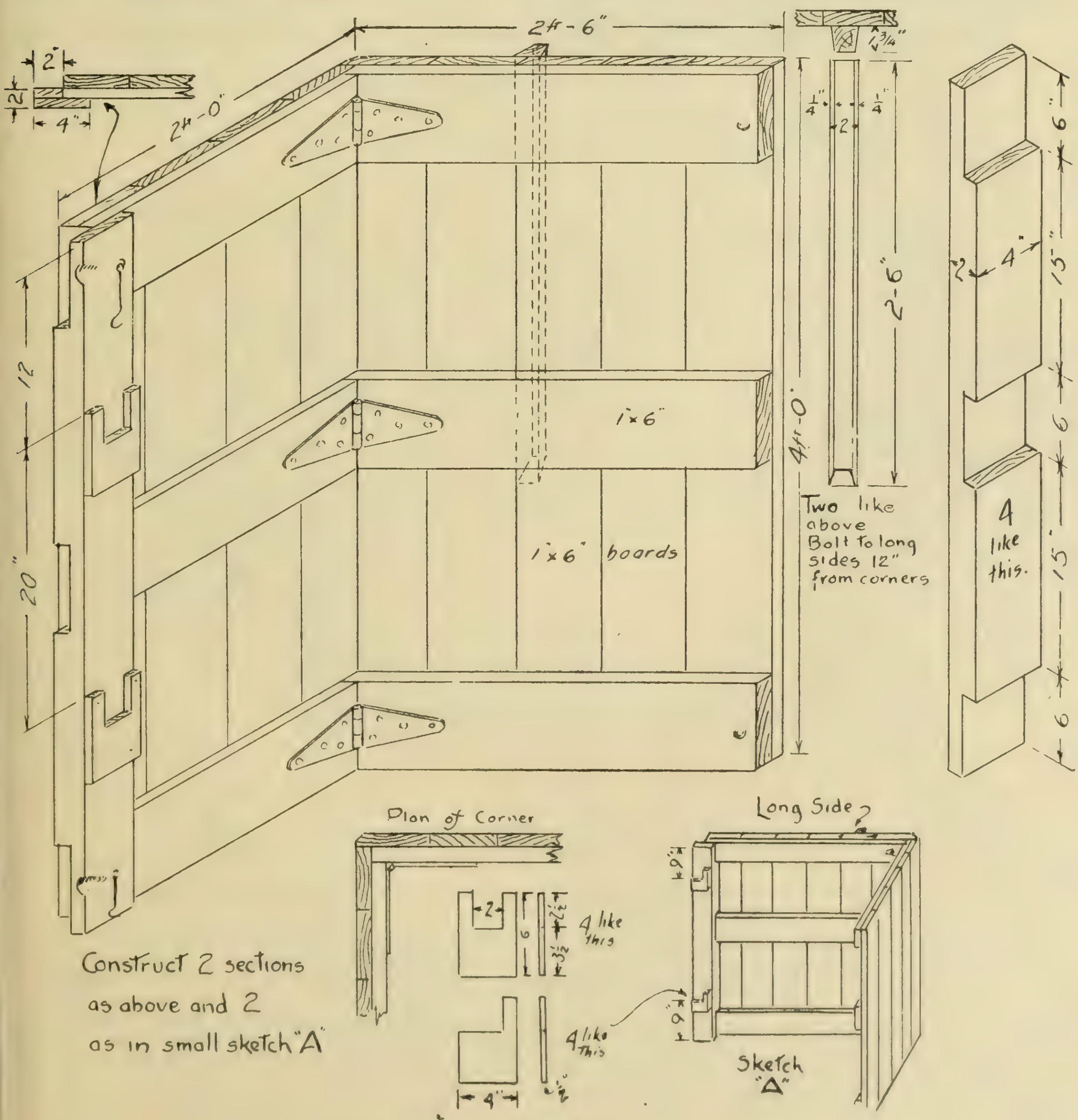
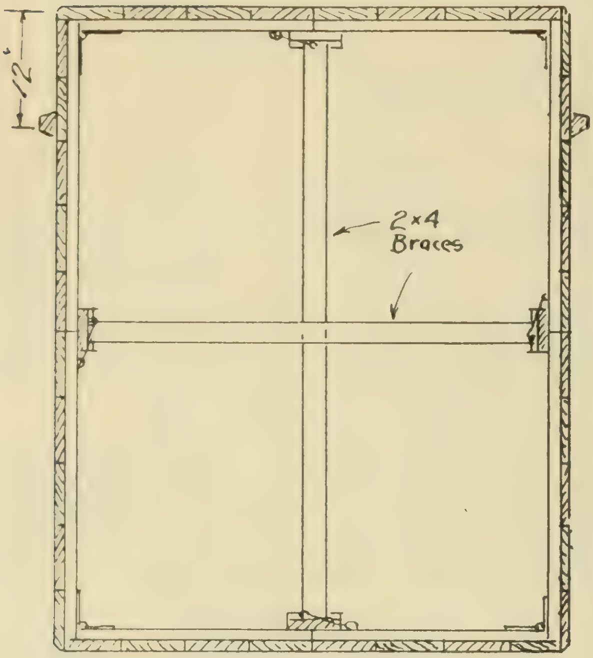


Fig. 1

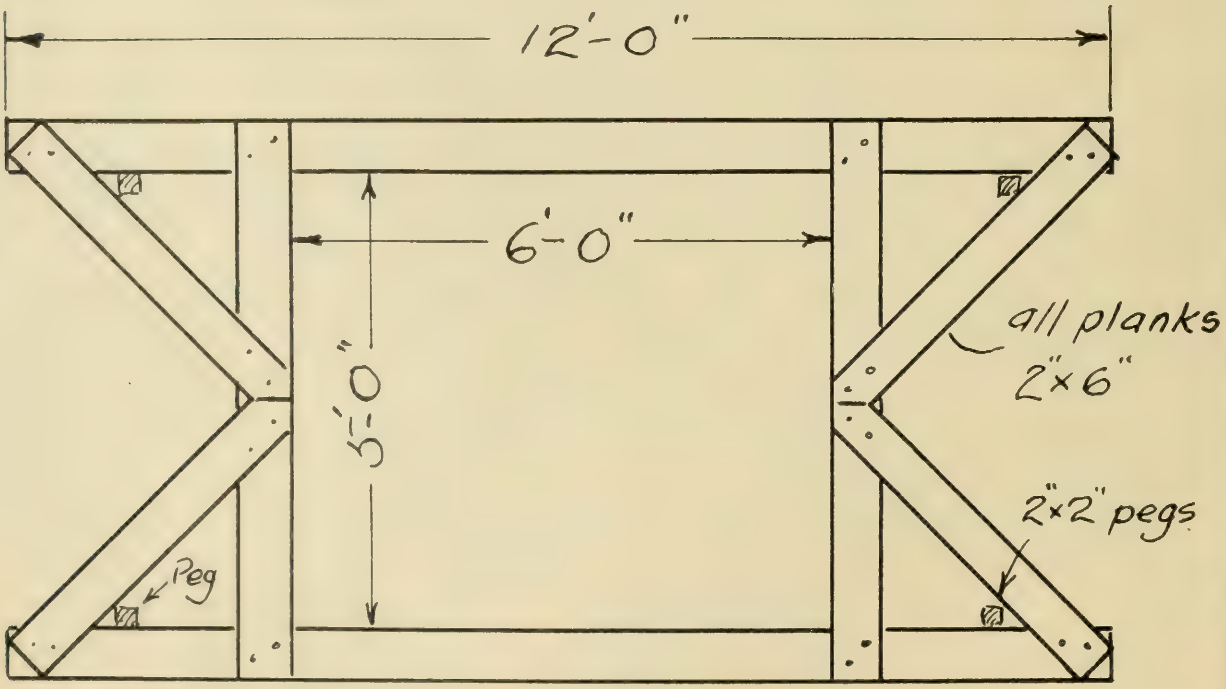


The site for the tank should be staked and lined out carefully, using a carpenter's square to true up the corners. The hole should be made exactly 6 feet long, 5 feet wide, and 4½ to 5 feet deep; and great care should be taken to make the sides perfectly plumb and keep the soil intact, as the earth sides have to serve as the outer form for the concrete wall. The soil should be taken away when it is thrown out. In place of stakes the form in Fig. 3 may be used.

Plan of interior mold for one chamber tank 4ft×4ft×5ft

Showing 4 sections hooked up

Fig. 2



A frame constructed as above and pegged so as to prevent shifting serves to outline the excavation and to prevent breaking of the edges of the excavation. It requires 3 pieces 2"×6"×12ft and 2 pieces 2"×6"×16ft. also 4 pegs 2"×2"×18"

Fig. 3

If the tank is built close to the cellar wall, it is absolutely necessary at this stage to break a hole in the cellar wall to accommodate the pipe line leading from the house into the tank. If the tank is built some distance away, this hole may be made after the tank is built. The hole should be 8 or 10 inches in diameter, and the grade in the pipe line not less than ¼ inch per foot.

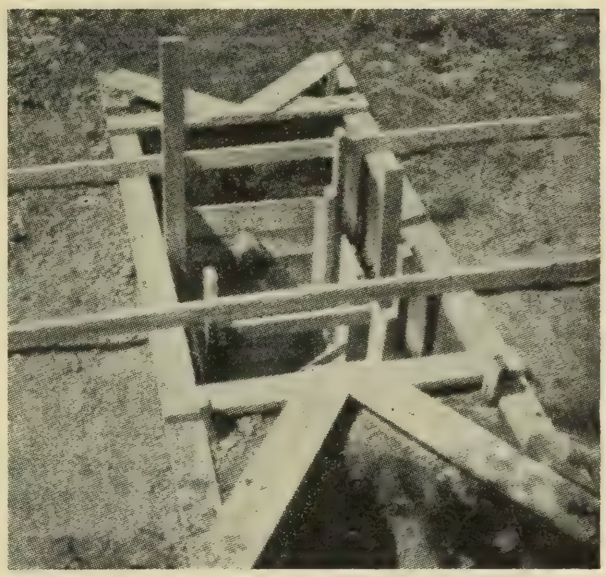


Fig. 4

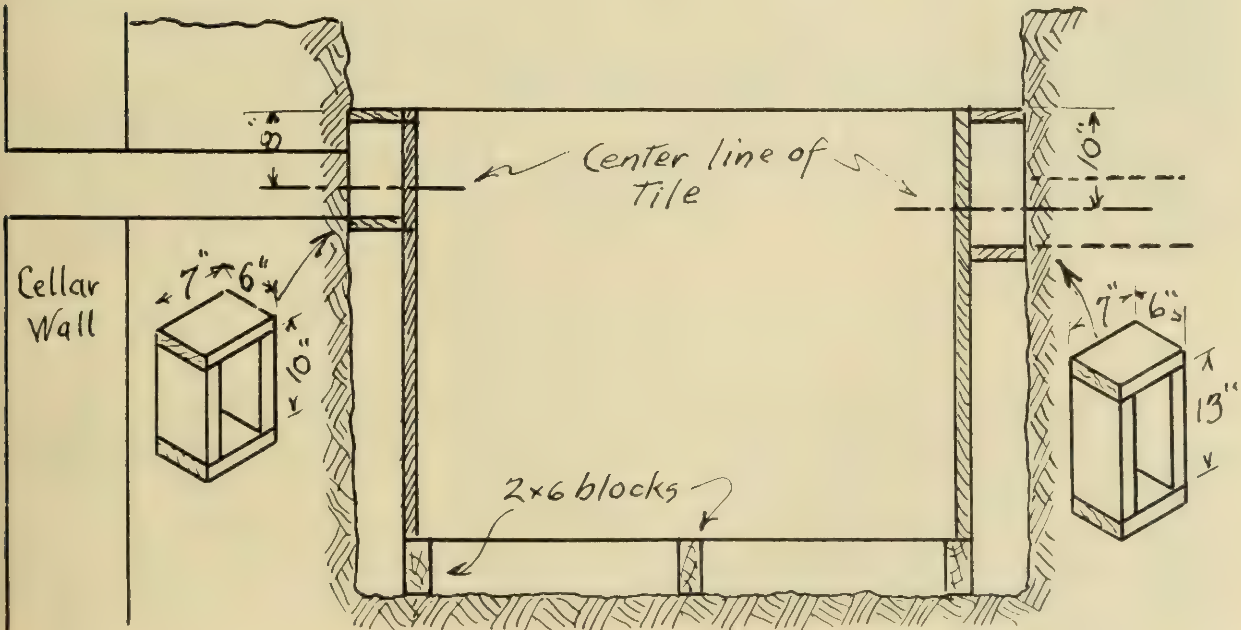


Fig. 5

STEP 3.—PLACING THE FORM IN POSITION

Oil or grease the outside surface of the form and then put the sections into the hole, with top ends up; then arrange them so that the two sections having mold on one side are at the outlet end of the tank (see Fig. 4), and hook the sections together. Then put blocks 2 to 4 inches thick under each corner and centre of each side to keep form free from the ground, or suspend as shown in Fig. 5 in order to make their removal easier afterwards. Next adjust position of form to provide for at least 6 inches of concrete on all sides, and make the form level; then drive short stakes into the ground at each corner inside the form to keep it in position while concrete is put in place.

BRACES

Four wooden braces are required inside the form, two at both top and bottom. These must be supplied by the user of the form; 2 by 4's are satisfactory. Two braces are required to be cut as shown in Fig. 2. They do not need to be nailed to the form.

CONCRETE WORK

The mixture for this job should be in the proportion of 1 sack cement, 2¼ cu. feet of No. 4 sand, 3 cu. feet of pebbles. The tank will take 13 sacks of cement, 1⅓ cu. yards of sand, and 1½ cu. yards of pebbles. Sand passes a screen with four openings to the inch. Pebbles should not be larger than 1½ inches. A mixture of 1 of cement to 5 of gravel from the pit with not too much fine sand in it has in some cases been used satisfactorily. The above suggested mix is more reliable. Water should be clean and used in the proportion of 4 gallons to 1 sack of cement. All material should be measured. Mix sand and cement first to get an even colour. Then mix in the pebbles. After this last mixing add water to get a mushy but not soupy mix. Pour concrete into the wall, keeping it fairly level as you build it up. As it is added move a spade up and down in the concrete next the forms so as to push back the pebbles and leave a layer of mortar next to the boards on the inside face of the wall.

WOODEN SLEEVES

As the top of the wall is approached it is necessary to set in two sleeves to provide for openings in the finished wall for the inlet and outlet pipes, which are installed later. See Fig. 5 for details of construction. They are taken out of the wall when the inlet and outlet fittings are installed later on; and in order that they may knock out of the wall easily, they should not be nailed too firmly when made. Put brace between the two vertical walls of the wooden sleeves.

CONCRETE SLABS FOR COVER OF TANK

These slabs may be made at this stage or later when the floor is put in. A simple method of constructing a cover for the tank is shown in Fig. 6. The slabs should be reinforced with metal rods or wire free from rust, which may be available about the place. The concrete slabs should be carefully and well made, and while curing they should be kept moist and well shaded from the sun. They should be left at least one week to cure before being moved to the tank. Old horseshoes or rings of heavy wire may be put into the several slabs to make handling easier.

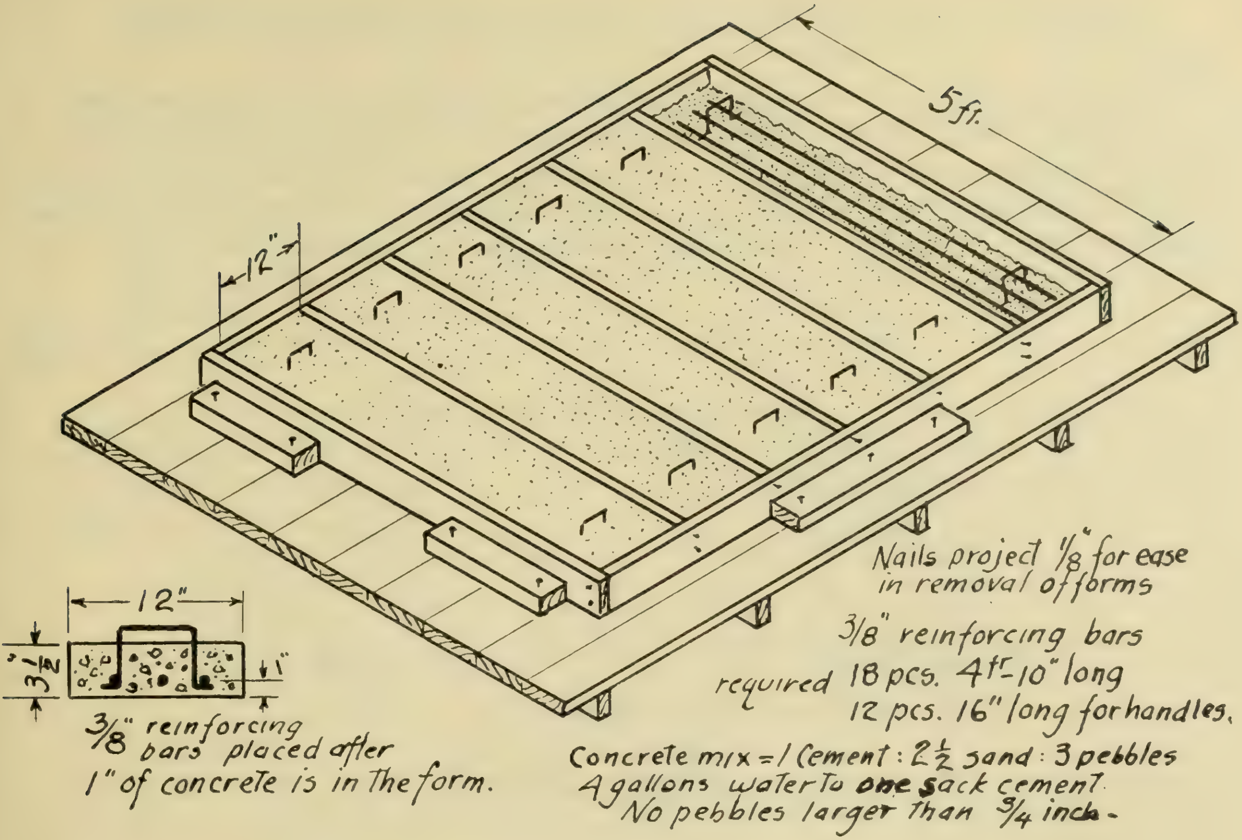

5 ft.
12"
12"
3 1/2"
1"
3/8" reinforcing bars placed after 1" of concrete is in the form.
Nails project 1/8" for ease in removal of forms
3/8" reinforcing bars
required 18 pcs. 4 ft-10" long
12 pcs. 16" long for handles.
Concrete mix = 1 Cement : 2 1/2 sand : 3 pebbles
4 gallons water to one sack cement.
No pebbles larger than 3/4 inch.

Fig. 6

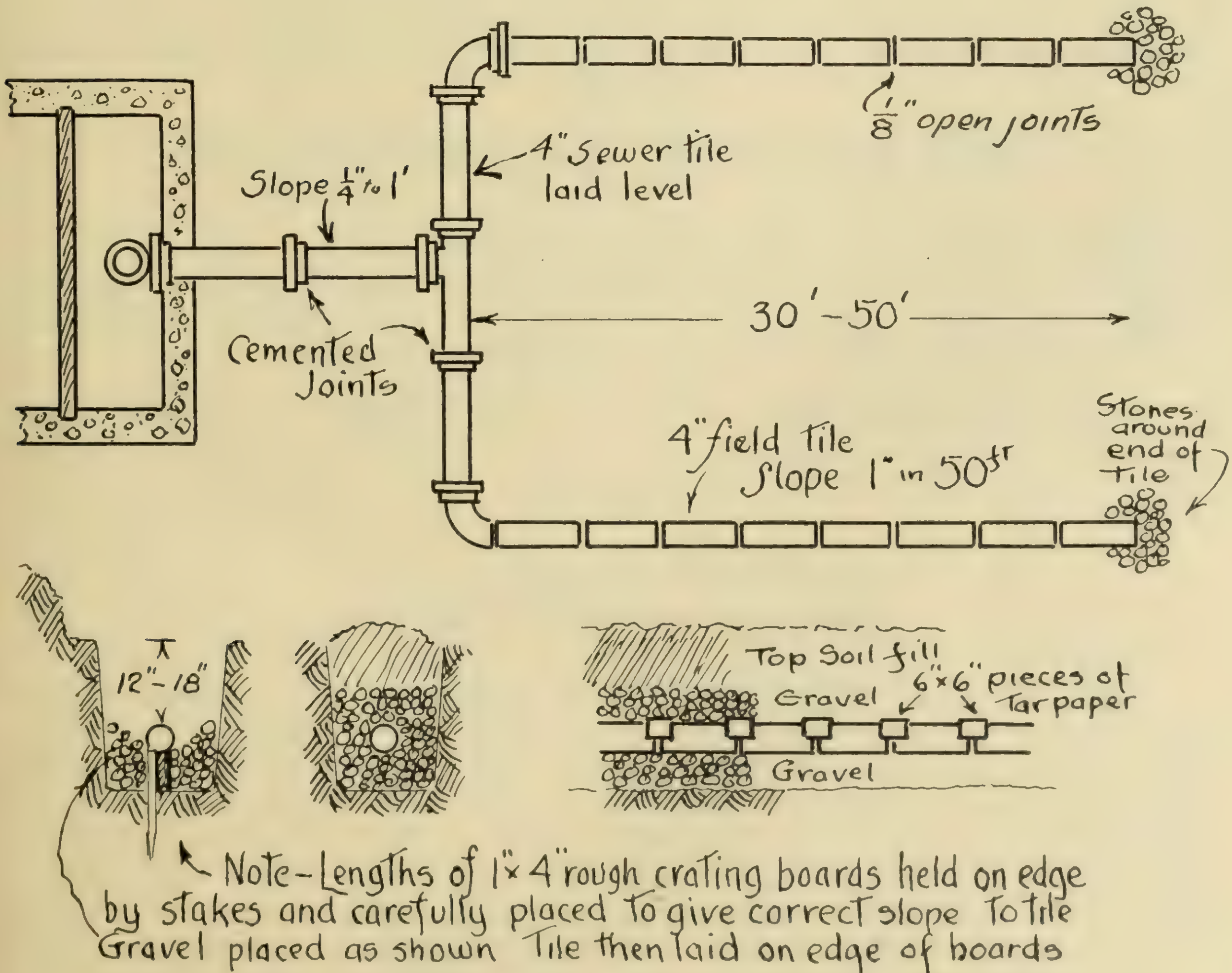

1/8" open joints
4" Sewer tile laid level
Slope 1/4" to 1'
Cemented Joints
30'-50'
4" field tile Slope 1" in 50 ft
Stones around end of tile
12"-18"
Top Soil fill
Gravel
6×6" pieces of Tarpaper
Gravel
Note - Lengths of 1×4" rough crating boards held on edge by stakes and carefully placed to give correct slope to tile
Gravel placed as shown. Tile then laid on edge of boards

Fig. 7

STEP 5.—INSTALLING THE ABSORPTION BED

While the concrete of the tank is setting, the work of digging the trenches and putting in the tile may be proceeded with. The matter of location of tile system was discussed in Step 1, and should be reviewed at this time. All the details concerning the construction of the absorption bed are quite fully illustrated in Fig. 7, and they should be followed very carefully.

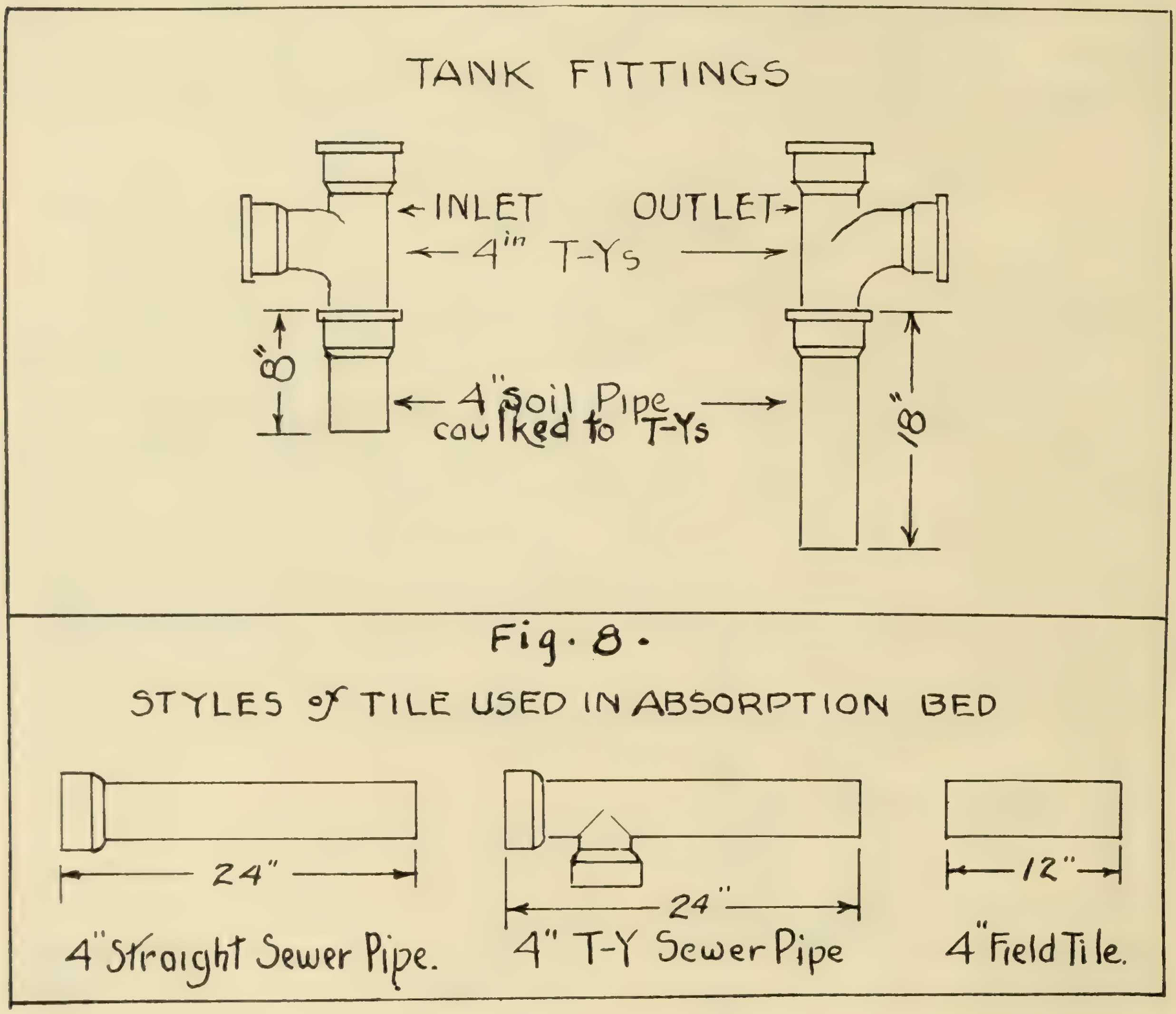


Fig. 8

KIND AND QUANTITY OF TILE

There are three kinds of tile required: 4-inch cast-iron soil pipe between house and septic tank; 4-inch sewer pipe between septic tank and the absorption bed, and also for the main line to which the laterals are joined, and 4-inch field or drainage tile for the laterals. The sewer pipe is 2 feet long and the field tile is 1 foot long. It is not possible to state the exact quantity of soil pipe and sewer pipe needed, as these lines may vary considerably, but for field tile there should be about 20 per person in case of porous soils and 30 to 40 per person for heavy soils. Very heavy and poorly drained soils should be tile-drained first, and also the tile should be laid in plenty of gravel, as shown in Fig. 7.

GRADES

The grade or fall in the pipe line between house and tank, and between the tank and the absorption bed, should be not less than ¼ inch to the foot; more is preferable in the latter case, as it assists to carry the effluent well into the field tile lines. The grade in the laterals should not be in excess of 3 or 4 inches per row of 50 or 60 feet in clay soils, and slightly more in sandy soils. Our experience is that the laterals are usually laid on too heavy a grade, with the result that the effluent is not evenly distributed throughout the lines of tile.

It is very important that the main sewer pipe to which the laterals are joined should be laid perfectly level; and also the tiles in the laterals should be laid evenly and on a firm bottom to give free passage of effluent along the lines.

STEP 6.—TAKING OUT THE FORM AND CLEANING IT

After a couple of days the form may be taken out. To do this remove the braces, unfasten all the sections, remove nuts from bolts holding the two molds in place, and pull each section away from the concrete and lift them out of the tank. Then carefully remove the two molds from their grooves and bolt them onto the form. The form should be thoroughly scraped and cleaned and put away out of the sun.

STEP 7.—PUTTING IN THE BOTTOM

The bottom may be put in the tank when the walls are built if desired; but from the standpoint of removing the form, it is handier to put in the bottom last, taking care to secure a good bond between the bottom and the walls. Clean thoroughly the surface of the walls where they contact the bottom.

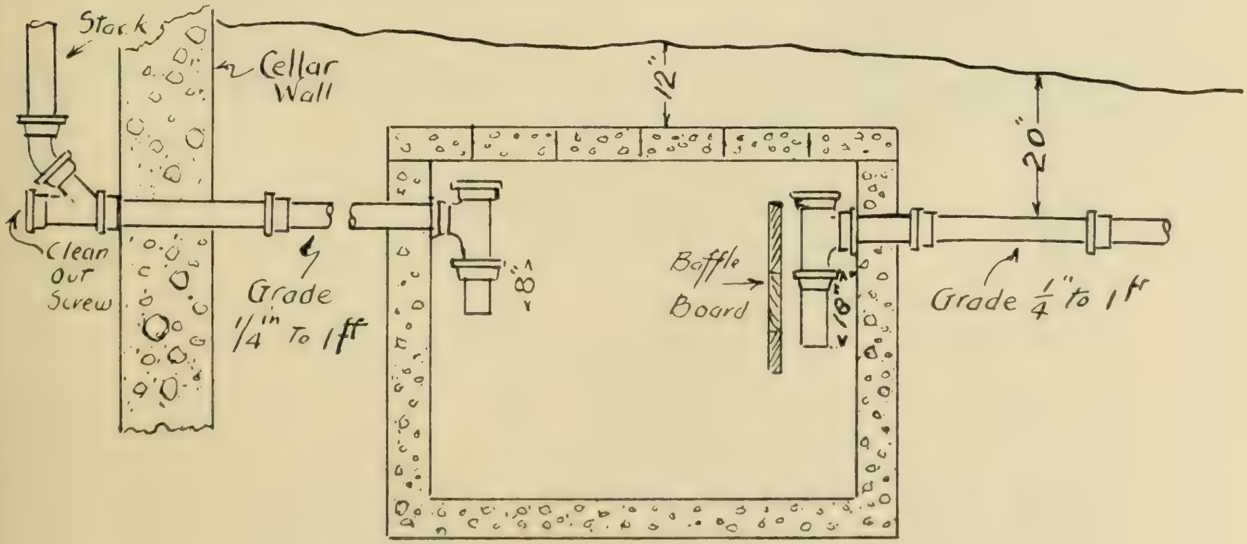


Fig. 9

STEP 8.—PUTTING IN THE INLET AND OUTLET PIPES AND WATERPROOFING THE INSIDE OF THE TANK

Remove the wooden sleeves and set in the inlet and outlet fittings, and fill in the slots with concrete to level of top of wall. These fittings should be very carefully cemented in place to prevent any leakage around them afterwards. Then mix up enough cement plaster about ⅜ inch thick, 1 part cement to 2 parts clean sharp sand. To this may be added 6 pounds hydrated lime to each sack of cement. This makes the plaster easier to handle. Coat the walls and bottom thoroughly, particularly around the pipes. Wet the walls and bottom before applying the plaster. Give the bottom a second coat.

STEP 9.—PLACING THE BAFFLE AND COVER

The baffle consists of a few pieces of 2-inch plank well soaked with hot asphalt or oil and cut to fit and placed in position in the grooves. The edges of ends should be rounded and should fit rather loosely in the grooves. There should be about 6 inches of space between top of baffle and the cover for circulation of air.

After the slabs for the cover have cured well enough to be moved safely, place them on the tank and cover the top with a foot or more of soil. The tank is then ready for use.

WINTER PROTECTION

Before winter sets in, the tank should be covered with a heavy layer of strawy manure to keep the temperature in the tank from dropping low enough to seriously check bacterial action in the tank. This protection is very important.

PRECAUTIONS

1. It is preferable not to empty weekly wash-wastes into the septic tank, as too much very soapy water temporarily interferes with the bacterial action so essential to the operation of the system.
2. Remove the sludge from the bottom of the tank at least once every five years. It may be pumped out, leaving most of scum in tank.
3. Use disinfectants in toilet bowl and sinks with discretion, and afterwards flush them out with plenty of water.

BILL OF MATERIAL AND ITS APPROXIMATE COST

(1)	3 loads gravel at $1.50 a load	$ 4.50
(2)	12 sacks cement at 70c. a sack	8.40
(3)	2 TY's (cast-iron) for inlet and outlet fittings at $1.25 each	2.50
(4)	1 T sewer pipe	1.20
(5)	10 4-inch sewer pipe, straight, at 50c. each	5.00
(6)	1 length of 4-inch soil pipe, double hub	3.00
(7)	2 4-inch sewer pipe elbows at 45c. each	.90
(8)	150 4-inch field tile at 5c. each	7.50
		$33.00

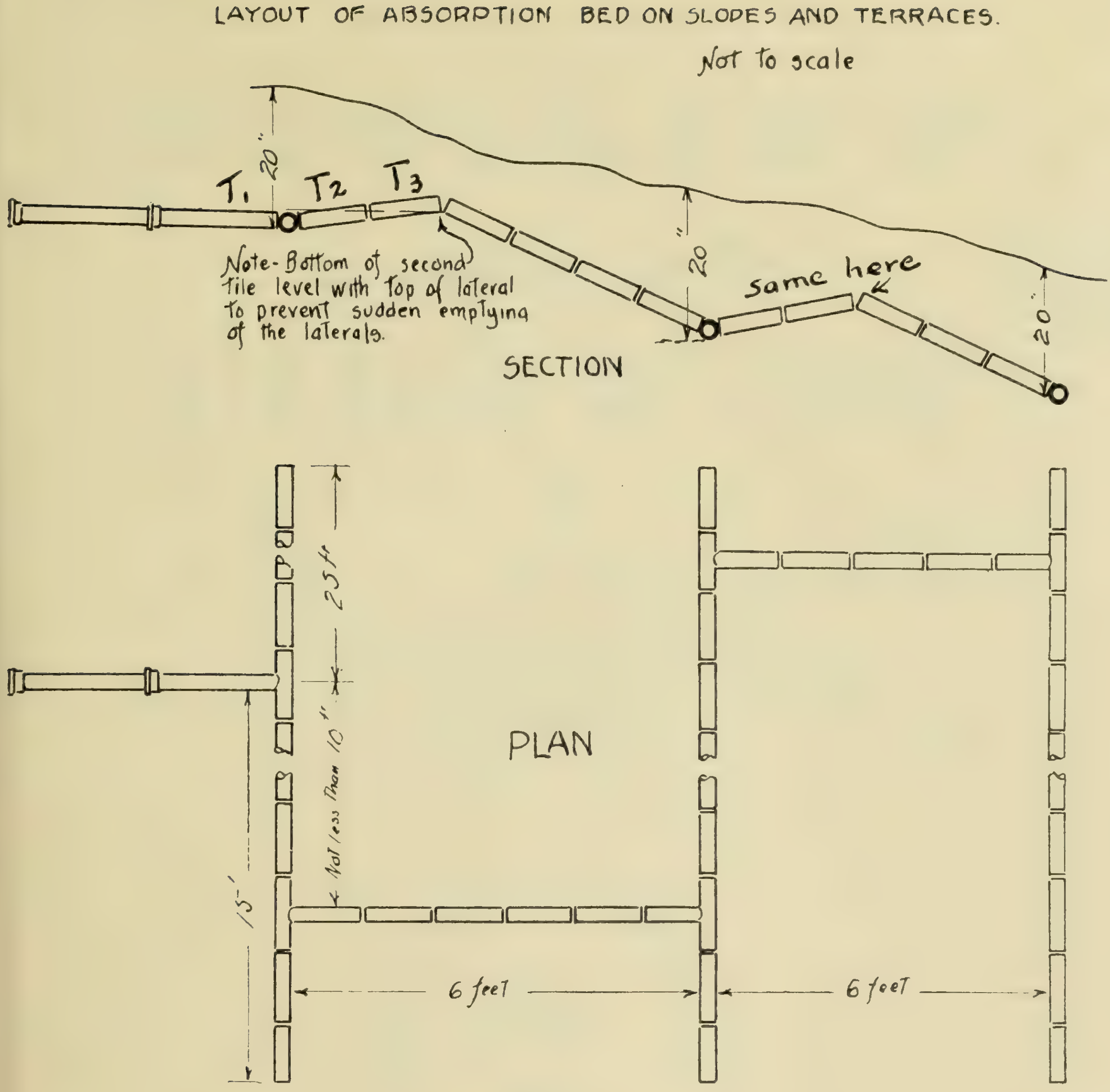

LAYOUT OF ABSORPTION BED ON SLOPES AND TERRACES.
Not to scale
20"
T1
T2
T3
Note- Bottom of second tile level with top of lateral to prevent sudden emptying of the laterals.
20"
same here
20"
SECTION
25 ft
Not less than 10"
PLAN
15'
6 feet
6 feet

Fig. 10

ABSORPTION BED ON SLOPES OR TERRACES

Where level ground is not available for the absorption bed, the tile are laid as in Fig. 10. If a siphon is used and sufficient water is flushed at one time to fill all of the absorption tile, the diagram as shown in Fig. 10 is correct, with tile T_2 and T_3 sloped upward till the bottom of T_3 is on a level with the top of T_1. Fig. 10. Keep the bottom of each row of laterals about 20 inches under the surface of the ground in each case.

ACKNOWLEDGEMENTS

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TEMPERATURE CONTROL
in relation to the
STORAGE OF FOOD

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ONTARIO DEPARTMENT OF AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 445 • MARCH 1945

FOREWORD

Numerous persons who have little or no technical information find themselves in a position where they must make decisions about the purchase of refrigeration equipment and insulation. They meet with claims and counterclaims about many items and they expect that disinterested opinion can give unqualified answers to their various problems. They fail to understand that blue-prints cannot be prepared in advance of knowing what their special installation is expected to do.

This publication is an attempt to place in the hands of persons interested in heat control much of the information he needs in, we hope, fairly readable form. It has been reviewed by both technical and non-technical persons and it is based on several hundred letters of inquiry. Comments on its usefulness will be appreciated so that revisions may be made in future editions.

TEMPERATURE CONTROL
IN RELATION TO
THE STORAGE OF FOOD

THE TRIBE OF B. T. U.'s

FIG. 1. Portrait of a "Heat Ghost."

Certain measurements and technical terms are familiar to everyone. For instance, everyone has some understanding of a gallon of oil, a yard of cloth, or a pound of butter. But, while coal is generally bought by the ton it is important to know its capacity to produce heat. The term commonly used as a measure of quantity of heat is the "British Thermal Unit", or, abbreviated as B. T. U. and it is not a term in common usage. The definition of a B. T. U. is, "that quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit". Heating appliances and the fuels used in them are used in the production of B. T. U.'s of heat. Refrigeration appliances and materials are used to absorb and remove B. T. U.'s from various things.

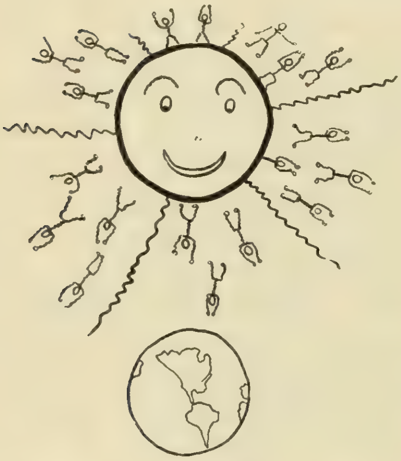
The control of temperatures is beginning to be a matter of more serious concern to everyone and this is written on the assumption that at least one individual in most households will have to familiarize himself or herself with matters which in the past have been confined to experts and textbooks. Most persons are beginning to realize that "keeping" foods is a fairly complicated matter of temperature control and not merely placing the foods in a "cool" place. Frozen foods are serving to emphasize the effect of controlled temperatures on food quality. The expert serviceman can keep automatic machines running but he can do no more than advise the householder or operator on how to use the food preserving machines properly. Such machines are capable of absorbing a certain number of B. T. U.'s of heat and if more than this number are fed into the machine results may be serious from the standpoint of especially, frozen foods. What follows immediately is an attempted introduction to the tribe of B. T. U.'s.

While no one has seen a B. T. U. of heat much is known about them. In some respects their behaviour resembles that of ghosts of allegedly human origin and so, for purposes of illustration the B. T. U. of heat has been given vague human form on the following pages.

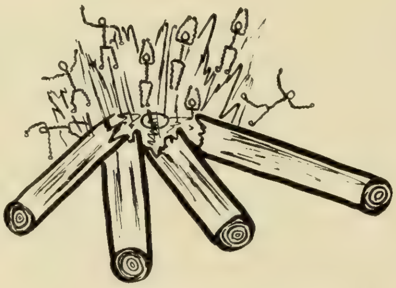
It isn't possible to destroy a "Heat Ghost" (B. T. U. of heat). It can disappear into anything that is available and it may or may not appear again to be either useful or destructive. Heat ghosts inhabit every "thing" whether the thing be living or dead.

"New" heat ghosts are born constantly. Nature provides them from the sun and from the depths of the earth. During our summer Nature's donations of B. T. U.'s from the sun are much too lavish for our comfort and for the proper preservation of food. The contrary is true in the winter. Heat ghosts are produced also by electricity, friction, and by burning various fuels. As a consequence we spend good money on insulation as a fence to either hold B. T. U.'s in or to keep them out. We also spend money to produce new B. T. U.'s from fuel or electricity and more money to remove them by various refrigeration devices.

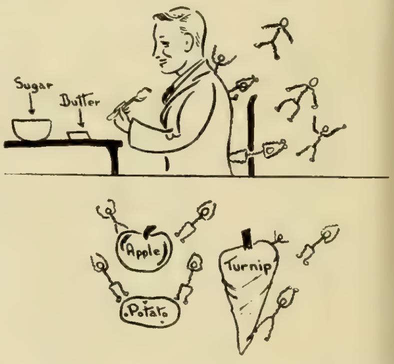
THE BIRTH OF HEAT GHOSTS



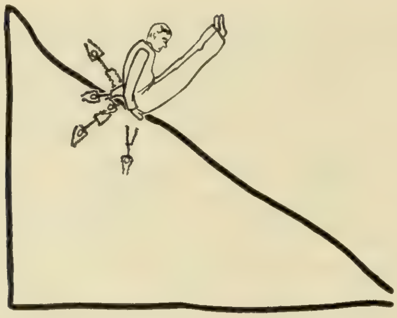
FIGS. 2. **From the sun.**



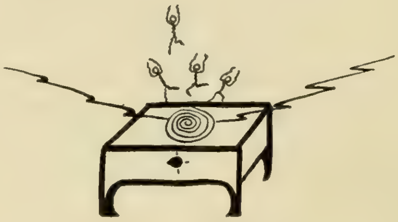
3. **From burning fuel.**



4. **From burning food in humans, animals, fruits and vegetables.**



FIGS. 5. **From friction.**



6. **From electricity.**

Heat ghosts are restless individuals and are continually in motion. Their tendency is to avoid crowds of their own kind and they will move from a thing which contains a lot of them to a thing which contains fewer of them. They appear to be most content when they are evenly distributed. In other words they always travel from the "*warmer*" thing to the "*cooler*" thing until both things have the same warmness or are at the same *temperature.* The relationship between what we call the "temperature" of any object and the number of heat ghosts it contains is a complexity due to the fact that it requires more B. T. U.'s to raise the temperature in some materials than in others. For instance, it requires one B. T. U. to raise the temperature of one pound of water 1°F. and it requires less than one B. T. U. to obtain a rise of 1°F. in one pound of any other material.

Heat ghosts travel by three methods: straight-line jumps (radiation), riding in air currents (circulation and "drafts"), and by "walking" right through solid matter (conduction). In this last respect they resemble traditional human ghosts which can pass through closed doors and stone walls. Heat travels from the sun by radiation only, as it does from the old-fashioned fire-place. Rooms are warmed largely by circulating air carrying heat from a warm object to all parts of the room. Much unwanted heat comes in through the roof and walls of a house by conduction in the summer, and heat units obtained from costly fuels escape from the house by the same routes in winter.

TRANSPORTATION OF HEAT:

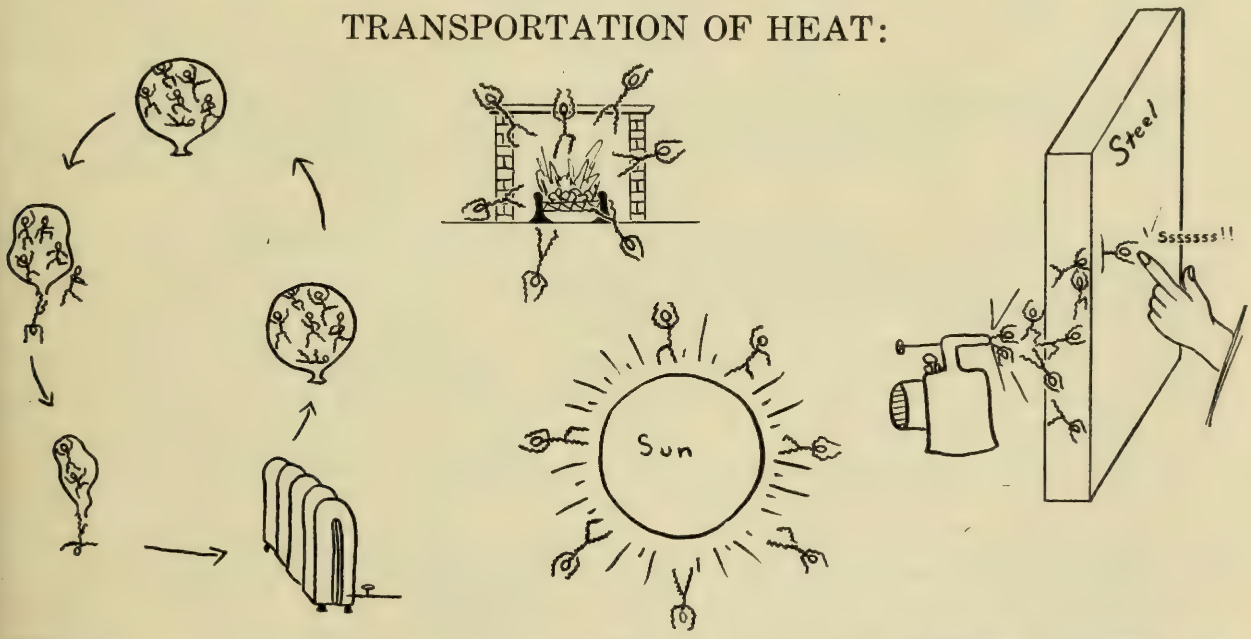


FIG. 7.
A Riding air currents. B Straight line jumps. C "Walking" through materials.

Heat ghosts travelling by radiation (straight line jumps) have to stop when encountering any object and travel through the object more slowly by conduction. If the object has a light colour or a shiny surface many of the heat ghosts bounce back just like light does and therefore such surfaces are used as one means of slowing the income or loss of heat ghosts to or from closed spaces such as rooms or "Thermos" bottles. In other words shiny surfaces serve as *heat insulators*.

Other types of *heat insulators* impede conduction (walking through) of heat ghosts. Solid, heavy substances like metals and stone impede heat ghosts much less than do materials that are lighter and often "fluffy" in texture. The heavy substances are known as *good heat conductors or poor heat insulators*. Those substances which are light and porous are generally good heat insulators.

When some heat ghosts leave an object it becomes cooler, if more heat ghosts come into the object it becomes warmer. Any object can be made warmer by putting it in contact with or in proximity to another object which is warmer. Conversely any object can be made cooler by contact with or proximity to another object which is cooler. Thus for purposes of straight thinking one has to forget common expressions such as "frost comes through the wall". It doesn't do that. Neither does frost penetrate the ground. In both instances all that happens is that enough B. T. U.'s

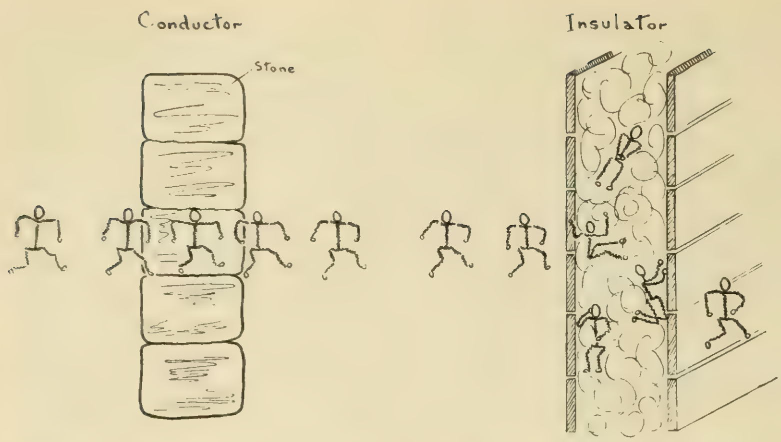


FIG. 8. Heat Ghosts walk readily through conductor materials but have difficulty getting through insulating materials.

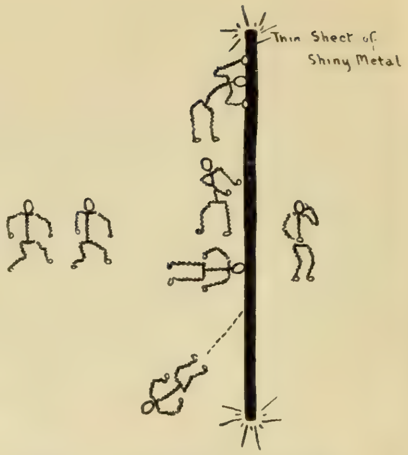

Thin Sheet of Shiny Metal

FIG. 9. Shiny or light coloured surfaces cause many Heat Ghosts to bounce back.

leave the wall or ground to go to some cooler object (such as winter air) to lower the "warmness" (temperature) of the wall or ground to or below the temperature at which water freezes.

Some other common expressions of speech lead to incorrect ideas and practices. For instance, "taking the heat out of food". No one has ever taken all the heat ghosts out of food though it is theoretically possible. The term *Absolute Zero* refers to a temperature in the neighbourhood of –460°F. and if food or any other object had enough B. T. U.'s removed to bring it to that temperature there would be no B. T. U.'s left and it would be proper to say that "the heat had been taken out of the food". Merely freezing food or any other object leaves plenty of B. T. U.'s in it. Or in other words, frozen things can be cooled further by removing some more B. T. U.'s. It should be noted that the B. T. U.'s still in cooled or frozen foods are active and in many instances are destructive. The term "cool" as ordinarily used has either very little meaning or too many meanings. For instance, if one were cooking steel a temperature of 500°F. would be too cool but if one were cooking bread it would be too hot. A temperature of 50°F. is too cool for comfort in a home but it is too hot for long storage of most foods. Then, while most foods will freeze hard at a temperature

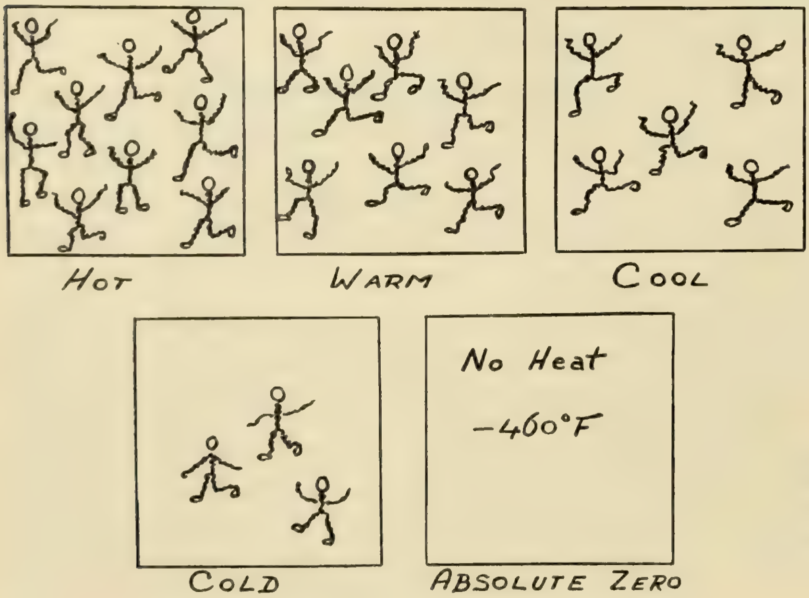


FIG. 10. Words describing warmness or coldness refer merely to how many Heat Ghosts are present.

of 25°F. they are still too warm (contain too many heat ghosts) to keep well.

Ordinary ghosts of departed humans are supposed to do many things such as rattling tables and chains. Heat ghosts are much more useful and also much more destructive. Crowd enough of them into steel and they almost literally kick it into a liquid. Crowd them into water and they kick it into a dry gas called steam or water vapour. Chemical changes in all sorts of things are speeded up by heat ghosts and some of the chemicals called vitamins become useless material quickly when too many heat ghosts are present. Raw fruits and vegetables are living, breathing, feeding organisms which, if allowed intimate relations with too many heat ghosts, have a fast but short life. But if too few heat ghosts are present the fruits and vegetables may be injured or killed. We have to harbour enough heat ghosts to hold our body temperatures at about 98.6°F. but if enough of them move in to raise our temperature to around 105°F. we are heading in the direction of becoming ghosts ourselves. If we don't harbour enough heat ghosts we again tend to become ghosts ourselves.

If a room in a house is losing heat ghosts through the walls faster than the furnace or humans are supplying them, the temperature of the room drops, but if heat ghosts are coming into the room faster than they can get out the temperature of everything in the room goes up. There isn't any such thing as a "frost-proof" building or room. If a building were insulated with the best insulating materials and the materials covered the walls, ceiling, and floor many feet thick, heat ghosts trapped inside would gradually get out if the building were exposed long enough to any temperature lower than the temperature inside the building. But if a few persons or a few boxes of apples, or some other source of heat ghosts were in the building they may supply heat ghosts as fast as or faster than they

EFFECT OF TOO MANY HEAT GHOSTS

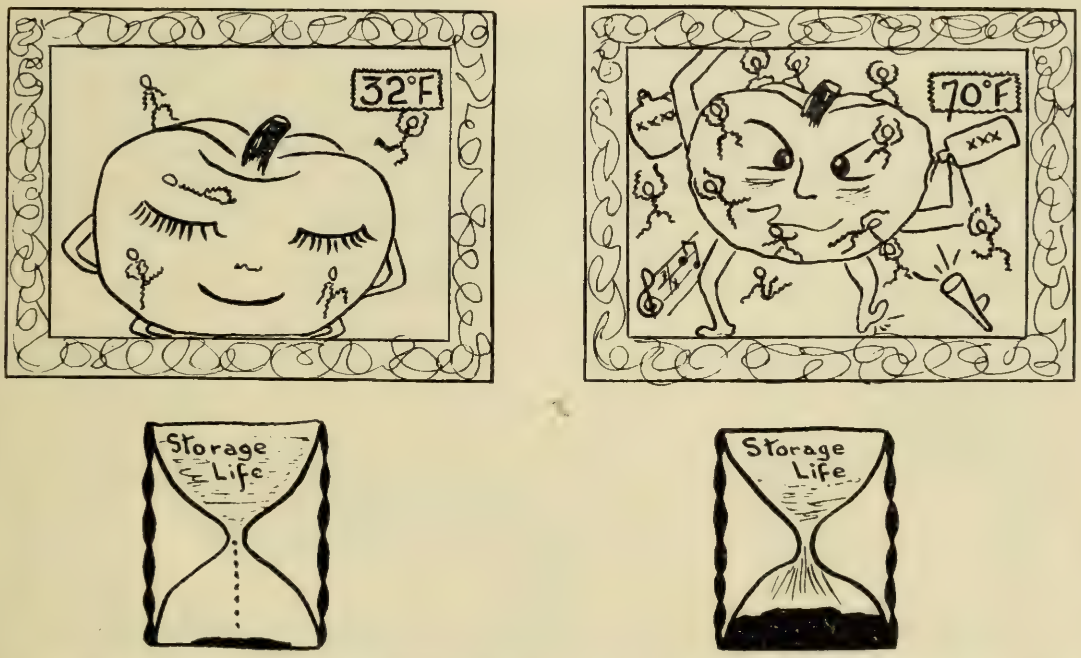


FIG. 11. The right number of Heat Ghosts allows fruits and vegetables to live a long, useful, storage life. Too much heat makes such foods lead a fast, short, storage life.

can get out and therefore the temperature inside of the building will remain steady or will tend to rise.

Temperature control, then, is balancing the number of heat ghosts gained against the number of heat ghosts lost from the thing in which you desire to maintain an even temperature. You decide previously how many heat ghosts are desirable to keep yourself comfortable, or to make an apple live longest, to keep a piece of frozen food in good condition, or to cook a cake. Then you decide at what point the mere holding of heat ghosts (by insulation) becomes too costly or too cumbersome, as against supplying them by burning fuel or electricity, or, as against removing them by refrigeration.

REFRIGERATION EQUIPMENT

The function of refrigeration equipment, both ice and machinery, is to remove some of the heat ghosts from an enclosed, insulated space to the outside of such space. A block of melting ice has a temperature of 32°F. and if it is put into a space having a warmer temperature, heat will move into the ice. The heat changes the ice to water and the heat is then in the water. If the water is drained out of the enclosed space the absorbed heat goes with it. If more heat is being removed from the space than is being put in or is being generated from raw fruits and vegetables, or is getting through the insulation, the temperature will be lowered in the enclosed space.

The heat absorbing part of mechanical refrigeration generally consists of metal pipes, with or without finned surfaces. The pipes carry a gas or liquid which is cooler than the temperature desired in the room or box which is to be cooled. Heat passes from the air in the room through the metal of the pipes into the gas or liquid in the pipes and the latter are constantly being pumped in and out of the pipes. The heat is removed

REMOVAL OF HEAT

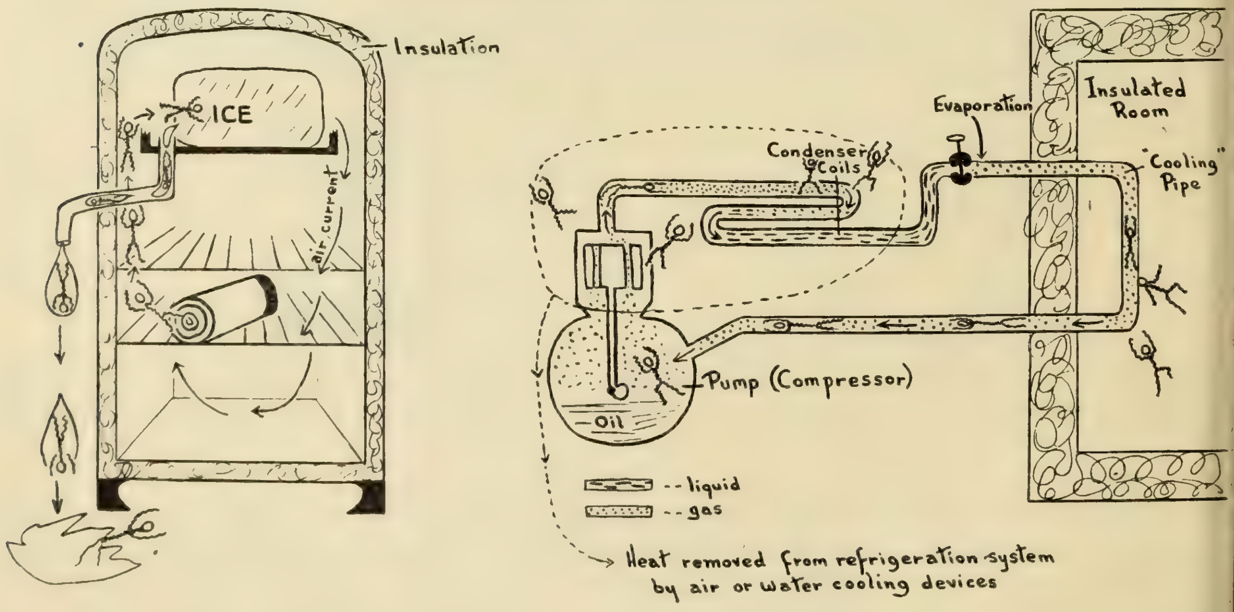


FIG. 12. Heat Ghosts removed from an ice-cooled refrigerator go out the drain pipe. Heat Ghosts removed from a mechanically cooled refrigerator are removed by a cooling system on the machinery.

from the moving gas or liquid by the cooling system on the pump. This pump is generally called a compressor and it is situated outside of the room or box. When enough heat is removed to lower the temperature of the enclosed space to a desired point, either the pump is stopped or a valve is shut so that the cold gas or liquid stops circulating in the pipes in the enclosed space. The pipes then tend to become the same temperature as the room and no further cooling takes place until gas or liquid is circulated in them again. The valves and compressor may be actuated by hand or by means of gadgets which work automatically. The most common gadget is a Thermostat which breaks and makes an electric circuit under the influence of the heat in the enclosed space. The controlled electric current starts and stops a motor on the compressor, or closes and opens valves by means of a motor or electro-magnet.

INSULATION

Any material, even metal, offers some impediment to the movement of heat ghosts in or out of a closed space but some materials slow up the movement of heat ghosts more effectively than others. The best of these materials are called "heat insulation" materials. Two inches thick of a material offer twice the resistance to the passage of heat ghosts as does one inch, four inches offer four times the resistance of one inch, and so on. Most materials are rated on how much heat will pass through a one-inch thickness of the material in question. Other factors have to be taken into consideration. Heat ghosts travel more quickly between objects having great differences in temperature than they do between objects of nearly the same temperature; in fact, heat will travel ten times as quickly when two objects are 10°F. apart than when they are 1°F. apart in temperature. Also, four times more heat can move through four square feet of wall surface than can move through one square foot of wall surface. And finally, twenty-four times as much heat can pass through a given area of wall in twenty-four hours as can pass in one hour. For convenience, the insulating value of any construction material is stated as its "K" value. Its definition is: "the number of B. T. U.'s that will pass through one inch thickness, of one square foot area, in one hour, with one degree Fahrenheit difference in temperature between the two sides." A material having a high "K" value is a poor insulator (good conductor), and one having a low "K" value is a good insulator (poor conductor).

Table 1 lists a number of materials which are rated according to their "K" value.

The insulating effects of most materials depend on trapping small particles of air, for while moving air can carry heat easily from one place to another, still air is a good insulator. The only way to hold air "still" is to enclose small bits of it. Therefore it is important to pack some types of insulation to the right firmness so that the air pockets in it are correct in size. That factor is indicated in Table 1 by a figure showing the pounds of material to be put in each cubic foot of space. Other materials which are not packed when installing them are listed as weighing so much per cubic foot because sometimes a structure has to be strengthened to support the weight of the added insulation.

A low "K" value is the first requirement of an insulation material

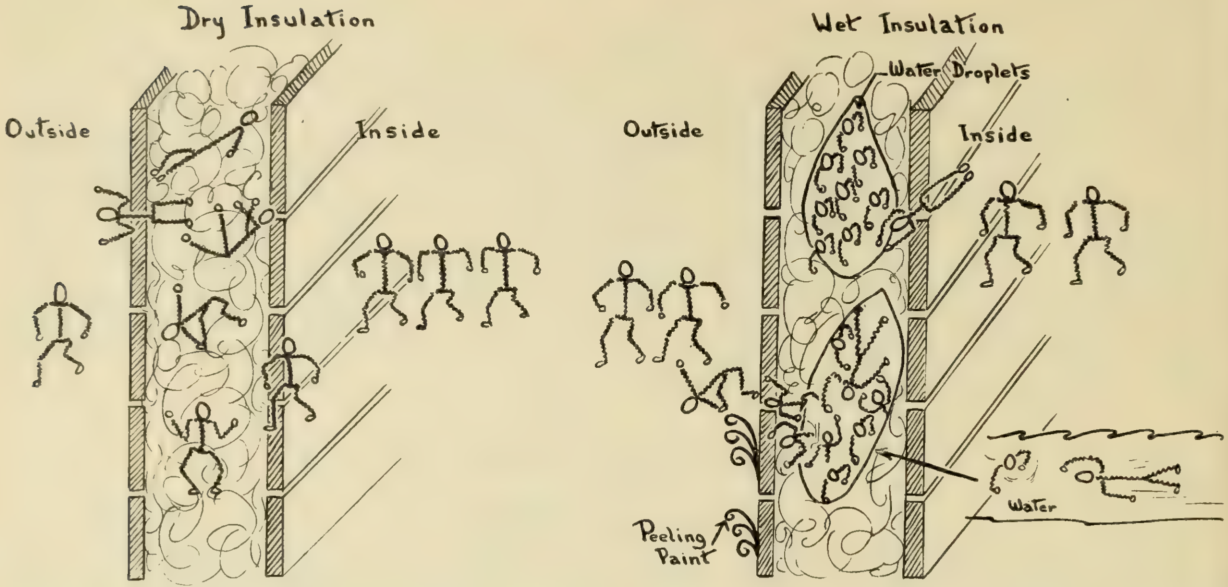


FIG. 13. **Dry insulation greatly slows the passage of heat ghosts. Damp insulation allows heat ghosts to "swim" through the moisture.**

but other factors influence the choice of material. Those materials having most of the desirable characteristics tend to be more expensive than those having only a few of such characteristics. The following are desirable in insulation materials:

1. Low "K" value.
2. Fireproof or resistant to fire.
3. Obnoxious to rats, mice, squirrels and insects
4. Resistant to water absorption.
5. Resistant to decay caused by moulds and bacteria
6. Light in weight.
7. Easy to install.
8. Does not settle so as to leave uninsulated spaces.
9. Low cost.

These characteristics are noted in materials listed in Table 1.

Moisture in Insulation

One of the real problems in insulation is the prevention of deposits of water in the insulation. Water itself is a fairly good conductor of heat and if the insulation material becomes wet its insulation value is very much reduced. Moreover, many materials may break down or rot under such conditions and the presence of water within the walls may cause trouble with both the interior and the exterior finish of the walls. The difficulty with many cheaper materials which have a low "K" value is to seal them in such a manner that moisture is not likely to collect in them. The problem is not simply one of waterproofing the walls because water vapour can often penetrate where water itself cannot go.

Insulated walls are said to "breathe", or, when the air trapped in the walls is heated, expansion takes place and since the walls cannot be

TABLE 1

The "K" values given are rough averages only. Similar materials may vary in conductivity. The "K" value of manufactured insulation can best be obtained from the manufacturer.

R.—resistant NR.—non resistant A.—absorbent

Material	Approx. "K" Value	Packing Needed or Weight per cu.ft.	Fire	Settling	Water Absorption	Rots	Rats Mice	Remarks
Corkboard	0.3	8 lbs.	R	None	Slight	R	R	A common insulation material.
Glass Wool	0.3	4 lbs.	R	None	None*	R	R	Sold in batt form.
Rock Wool	0.3	6-12 lbs.	R	Slight	None*	R	R	Often sold in batt form.
Redwood Bark Fibre	0.3	3 lbs.	Burns	None	Slight	R	R	In fairly common use.
Eel Grass	0.3	6 lbs.	Burns	Some	A	NR	NR	Seaweed, often sold in batts.
Peat Moss	0.3	11 lbs.	Burns	Some	A	R	NR	Difficult to dry and keep dry.
Sphagnum Moss	0.3	8 lbs.	Burns	Some	A	R	NR	
Straw	0.3-0.4	6 lbs.	Burns	Some	A	NR	NR	All are cheap, available, and have a low "K" value. Chemicals such as lime and bluestone dust can be added to prevent rotting and attack by Rodents. All are difficult to keep dry.
Buckwheat hulls	0.4	12 lbs.	Burns	Some	A	NR	NR	
Excelsior	0.4	6 lbs.	Burns	Slight	A	NR	NR	
Shavings	0.4	8 lbs.	Burns	Some	A	NR	NR	
Sawdust	0.4	12 lbs.	Burns	Some	A	NR	NR	
Fibreboard	0.4	18 lbs.	R	None	A	NR	NR	Such wall boards vary greatly in their various qualities. Some are sold with asphalt coatings.
Lumber (soft)	1.0	Lumber and paper are fairly good insulators, especially when used in combination with air spaces not over 1″ wide.						
Lumber (hard)	1.3							
Brick	5.0	The common, heavy building materials are fair conductors of heat. They conduct heat more than 10 times as fast as materials classed as insulators.						
Concrete	5.0-8.0							
Glass	5.0							
Water	4.0							
Steel	300.0							
Copper	2600.0							
Soil	?	Soil is seldom dry and on the average a 9″ thickness of soil is about equal to 1″ of a good insulator.						

* Do not absorb water, but water can adhere to the fibres and thus lower the insulation value

made air-tight some of the air is forced out. But when air in the wall is cooled the air contracts and the air from outside the walls is pulled in. If the air is moist the moisture is thereby introduced forcibly into the wall spaces. It should be remembered that the outer wall has about the same temperature as the outer air and the inner wall approaches the temperature of the inner air, while between the two walls is found the range of temperatures between the outer and inner walls. When warm, moist air contacts a cooler portion of the wall precipitation of water takes place. Since an insulated wall is designed to prevent air motion the precipitated water tends not to be removed by ventilation and each successive lot of precipitated water tends to accumulate in the insulation.

When loose insulating materials are packed into a wall the usual practice is to attempt to seal both sides of the insulation with heavy asphalt paper, using liquid asphalt to seal joints in the paper. The same types of materials can often be purchased in cushion-like batts which are completely sealed with asphalt paper and are of such a shape that they fit between studdings. More solid forms of insulation, such as corkboard, are purchased in slabs and are set into hot asphalt so that the whole surface of each slab is completely coated with asphalt when the installation is complete.

Only one type of insulation seems not to demand moisture-proof sealing and it consists of sheets of metal foil placed about one inch apart in the wall and which depends on the reflection of heat together with the narrow air spaces for its insulation value. Since the foil is made of non-corrosive metal any precipitated water merely runs down the surface of the foil and it has little or no effect on the insulation value of the foil or the air spaces.

Moisture has little effect on such insulation as glass wool but water tends to cling to the enormous surface presented by the threads of glass and thus lowers its insulating value. As a consequence even those materials which are not actually injured by moisture must be sealed for satisfactory results.

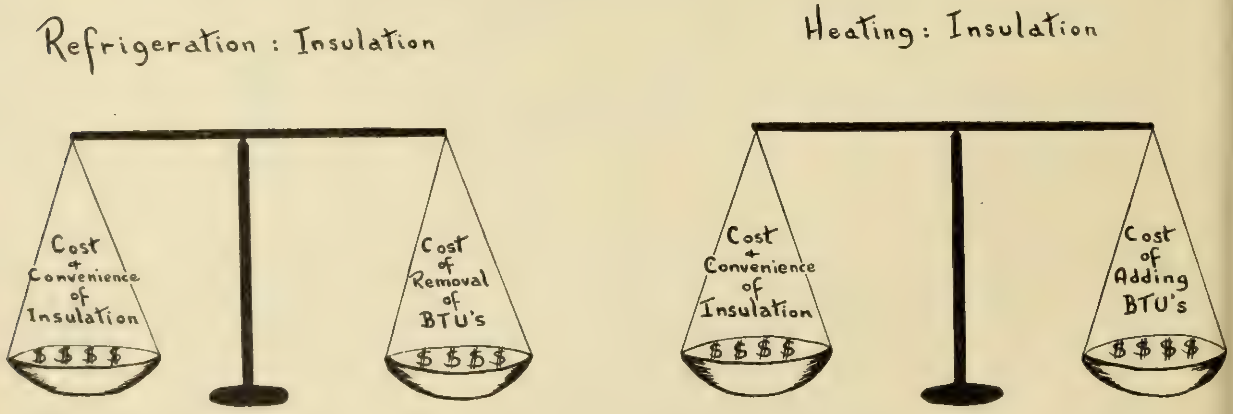

Refrigeration : Insulation
Cost + Convenience of Insulation
$$$$
Cost of Removal of BTU's
$$$$
Heating : Insulation
Cost + Convenience of Insulation
$$$$
Cost of Adding BTU's
$$$$

FIG. 14. Insulation makes necessary less fuel or less refrigeration. Insulation is necessary for an even temperature. Insulation helps to give comfortable surroundings.

BUT: Insulation costs money and more insulation costs more money. Insulation is bulky and takes up valuable space.

SOMEWHERE: There is balance between cost and convenience of insulation, and, cost of providing or eliminating BTU's.

Amounts of Insulation Needed

There appears to be no settled opinion about the most economical amount of insulation to use in a home. But the tendency is to recommend more insulation, and certainly the use of a good insulation up to four inches thick would result in decreased fuel bills and increased comfort. Opinion is fairly uniform regarding the amount of insulation necessary for various types of food storages. When the storage temperature is to be from 32°F. to 50°F. the insulation on the walls, ceiling and floor is a four-inch thickness of material having a "K" value of 0.3 or better. Rooms used to store frozen foods are insulated according to the temperature maintained and from six to eight inches of an insulation having a "K" value of 0.3 or better is used when the temperature to be maintained is around zero degrees Fahrenheit. Since the ceiling of a room tends to exchange more heat than the same area of wall it is sometimes advocated that slightly heavier insulation be used on the ceiling.

Kitchen refrigerators usually are fitted with less insulation than is desirable but more adequate thicknesses of insulation would result in too bulky a box, or a food storage space that is too small. If, however, food storage compartments ever become an integral part of the construction of homes, or if a householder builds his own food storage space, probably more insulation should be used.

ARTIFICIALLY REFRIGERATED FOOD STORAGES

Interest in refrigerated storages for fruits and vegetables, on farms particularly, is increasing markedly. It is impossible to give details of a suitable farm storage for fruits and vegetables because nearly all proposed farm storages are special cases. The products to be stored and therefore the layout and temperature requirements vary with each case; often an existing structure is to be used; sometimes a combination of refrigerated and common storage is needed; freezing facilities of various capacities may be needed; and finally, some compromise may be necessary because of the amount of money available for the project.

There is good agreement about the conditions under which various foods should be stored, whether they be chilled or frozen, and those data are summarized in Table 2. Where compromise conditions are found necessary advice should be sought from a government agency as to a most suitable arrangement.

Government agencies cannot advise on such questions as the relative merits of different manufacturers' machinery or insulation materials, and in any event the manufacturer enters into a contract with the individual about price, and guarantees of performance are given. It is possible to get a contract for the installation of both insulation and machinery from many companies, and it is the contracting company which decides such questions as power requirements and the type and amount of refrigerating surface (pipes or fin coils, etc.). Since performance of the machines depends partially on the insulation of the storage it is obvious that the manufacturer must be satisfied with the insulation used before he can give a guarantee of performance for his machine.

Manufacturers of insulation materials may contract for the insulation either on an installed or not installed basis, and many of them will contract for machine installation as well. When money is scarce the individual may find it economical to install the insulation himself and usually he can obtain full instructions from the manufacturer. He should be sure, however, that the machine company from which he intends to purchase equipment approves of the job.

Where estimates for either insulation or machinery are sought the companies must know the dimensions of each storage room, full detail about the construction of the building, the maximum number of pounds and the kind of food put in storage in a twenty-four hour period, and the rate of cooling desired for each commodity to be stored. The kind of power and whether or not running water is available is also necessary information.

An individual may decide to forego guarantees of performance and rely on his own judgement about both machines and insulation. He may purchase new or used equipment and rely on a refrigeration serviceman for installation and servicing of the equipment. When electric wiring passes through insulation, an Inspector from an electric company must approve.

Four expensive ways of "saving" money in the construction of refrigerated storages are:

1. Inadequate or carelessly installed insulation.
2. Insufficient power.
3. Insufficient room to allow for proper spacing, and therefore cooling, of the foods.
4. Insufficient cooling surface in each storage compartment. If the cooling surface is run at a very low temperature it is possible to obtain a wanted room temperature with a comparatively small, and less costly, cooling surface. But when the difference between the temperature of the cooling surface and the room is too great the tendency is for the moisture to be frozen out of the air of the room too quickly. This in turn results in too low a humidity for successful storage of most food stuffs and it may result in inconvenient and costly frost formation on the cooling surfaces. Generally speaking the temperature of the cooling surface should be about 5°F. (or less) below that of the wanted room temperature. Any reliable contractor will likely advise the use of adequate cooling surfaces and the individual should not allow the extra cost involved to interfere with a proper installation.

THE USE OF GROUND TEMPERATURES AND NATURAL AIR AS MEANS OF REFRIGERATION

Nearly everyone has drunk "ice-cold" well or spring water in midsummer but probably few people have stopped to think that the temperature of the ground where the water was collected must have been at the same "ice-cold" temperature. Actually such water is never colder than

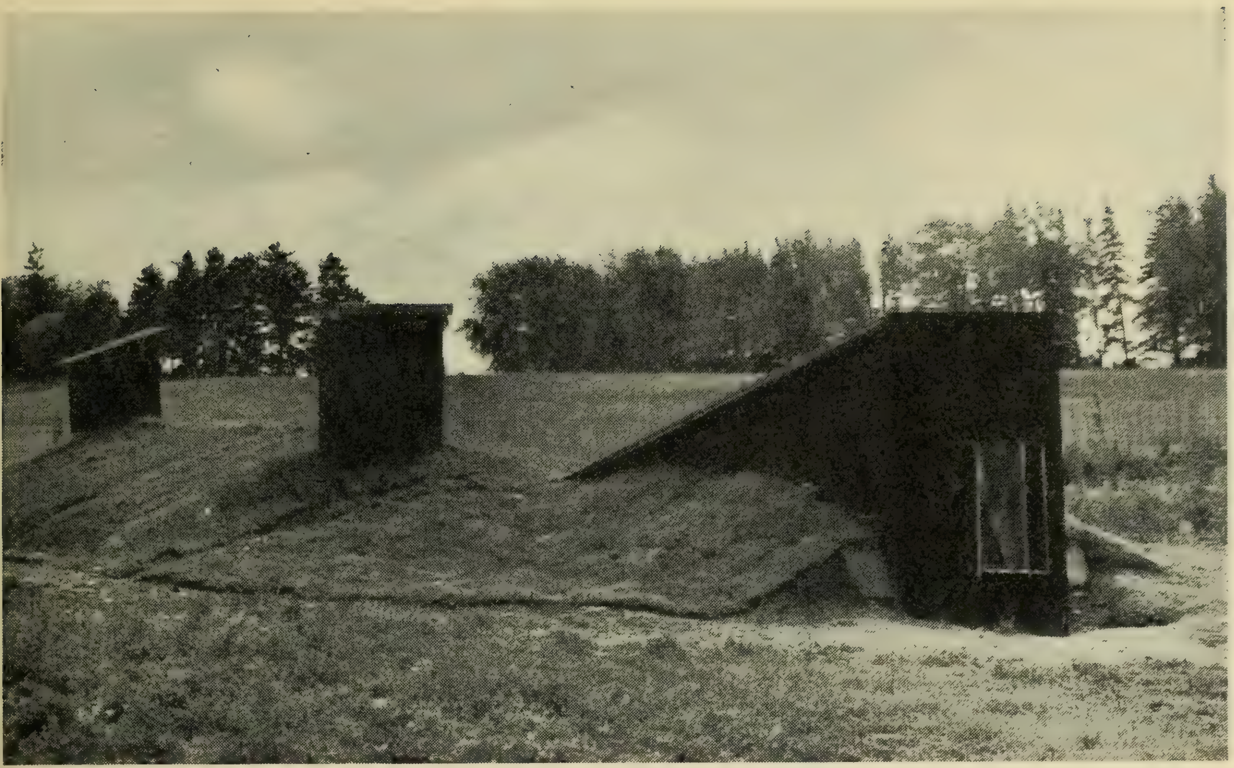


FIG. 15. A cellar type air-cooled storage. The nearer "chimney" is a cold air shaft opening at floor level. The more distant chimney serves to eliminate warm air from the ceiling of the cellar.

about 40°F. but such a temperature is useful for many cooling purposes. If, in Canada, one thinks of the areas where 95% of the people live, and therefore eliminate the Arctic regions, the soil temperature 6 feet below the surface of the ground remains at from 40°F. to 45°F. the year round. This applies to a considerable depth but really deep mines enter warmer soil or rock temperatures. The top six feet of ground fluctuates in temperature between winter and summer.

Where the drainage is good enough deep cellars and caves are used for such things as ripening cheese and wine since nearly ideal temperatures for such purposes are naturally maintained. Occasionally water from springs and wells is used as a cold-water bath around metal containers containing foods. In ordinary kitchen-type ice, or even refrigerated, refrigerators, the average temperature of the food space is seldom lower than 40°F. and this is a useful food preservation temperature even though

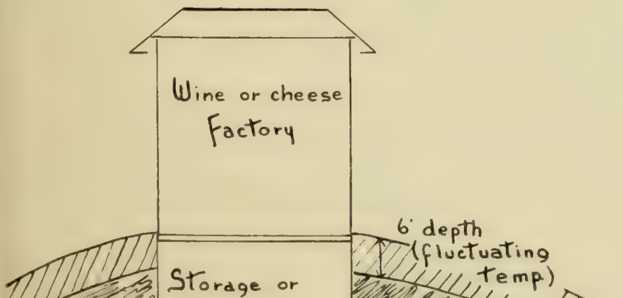

Wine or cheese Factory
6' depth (fluctuating temp)
Storage or ageing in deep cellar
40°F to 45°F
Soil Temperature 40°F to 45°F

FIG. 16. Very deep cellars or caves hold an even temperature of 40°F to 45°F throughout the year.

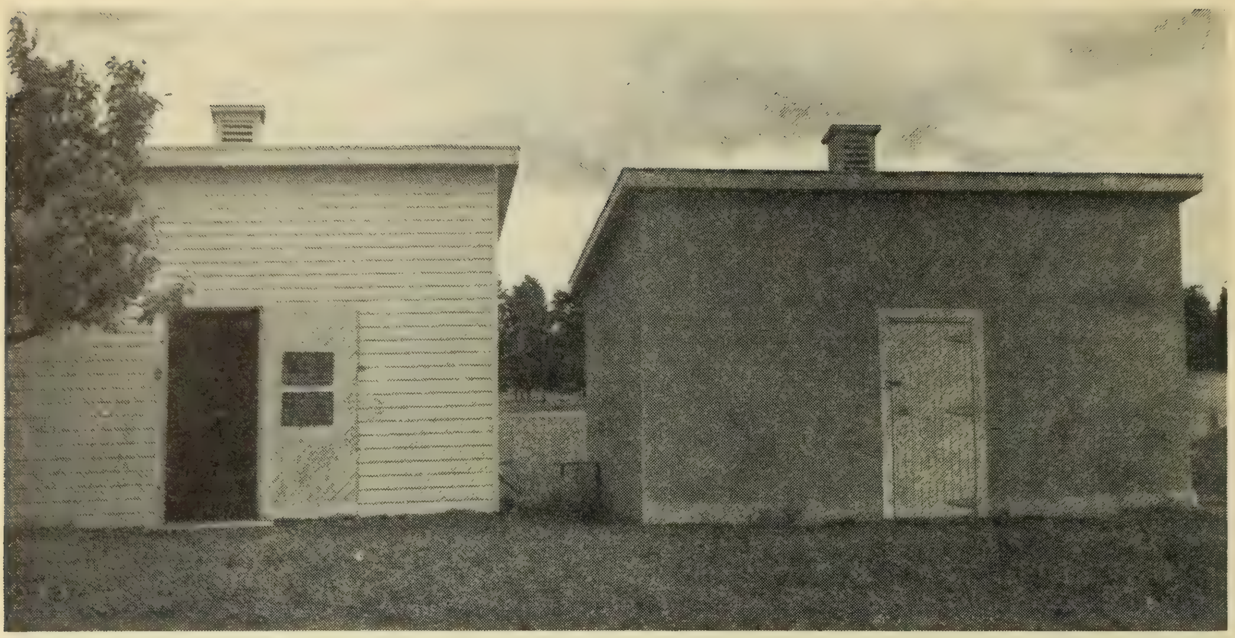


FIG. 17. Two insulated, air-cooled storages at the O.A.C., Guelph. Note the air inlets and the chimneys. They are useless in summer but they work well from November to April for any wanted temperature between 30°F and 50°F.

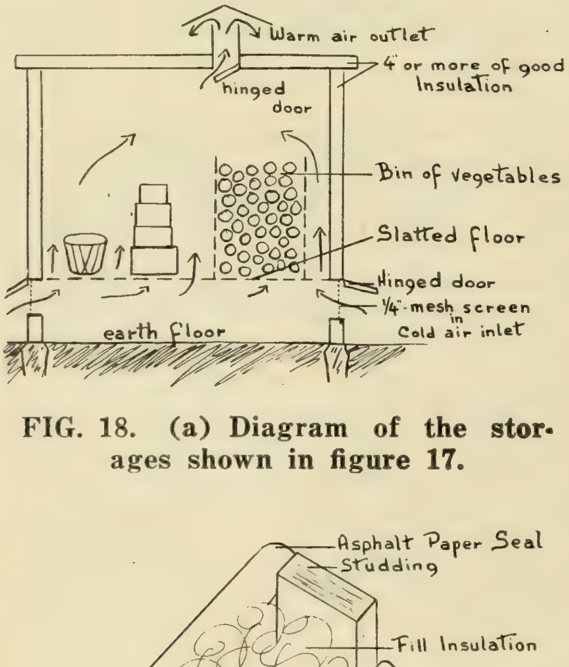


FIG. 18. (a) Diagram of the storages shown in figure 17.

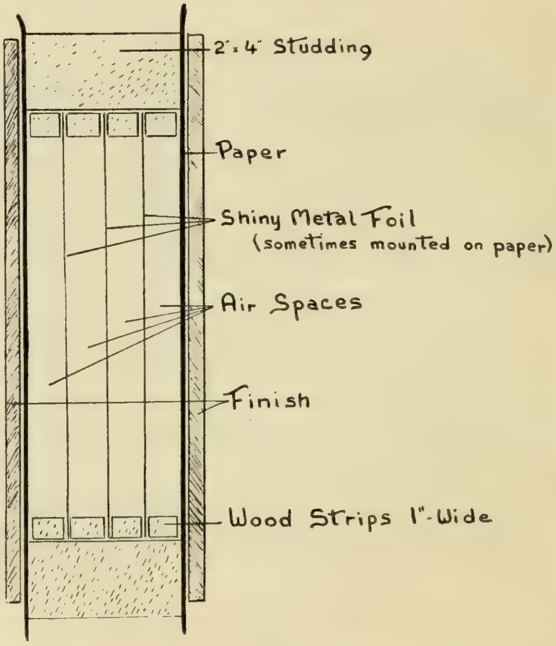


FIG. 18. (c) A type of insulation depending on shiny metal surfaces and narrow air spaces for its heat impeding effects.

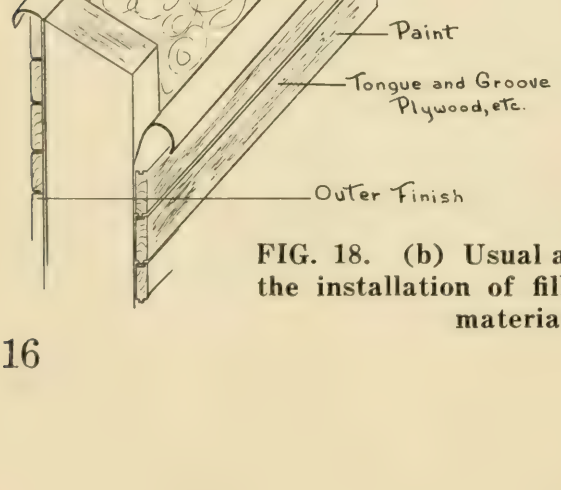


FIG. 18. (b) Usual arrangements for the installation of fill-type insulation materials.

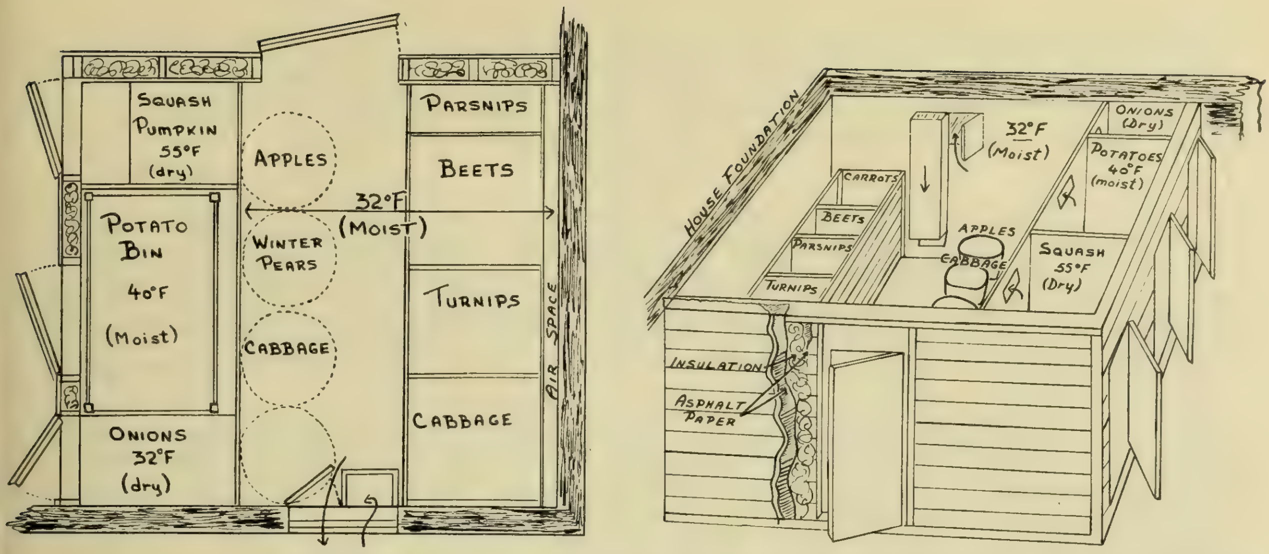


FIG. 19. Diagrams of a food storage in the corner of a house cellar. As shown, one cellar window is made to allow cooling air to pass in through one-half and for warm air to pass out the other half. If two windows are available use one as an air inlet and the other as an air outlet. Such a storage is not of much value in summer.

THREE TYPES OF ICE-COOLED COMPARTMENTS.

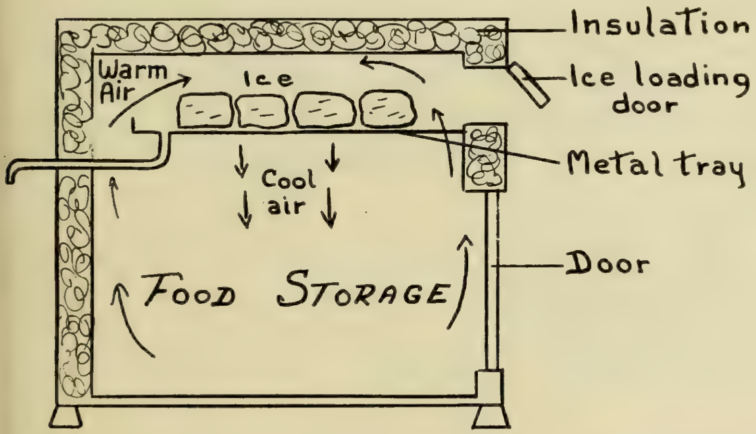


FIG. 20. (a) Overhead bunker.

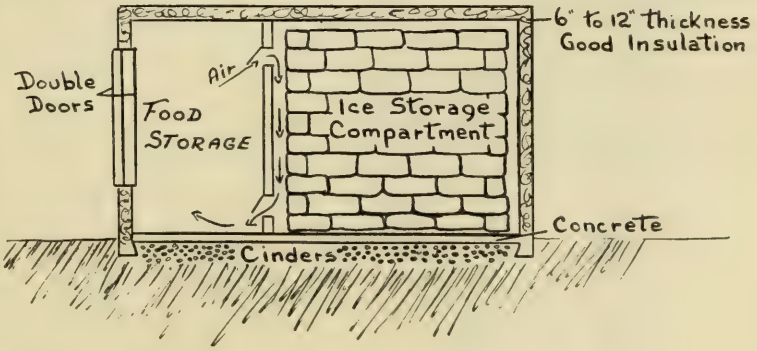


FIG. 20. (b) Combination storage for winter harvested ice and a food compartment cooled in summer by opening the doors to the ice compartment.

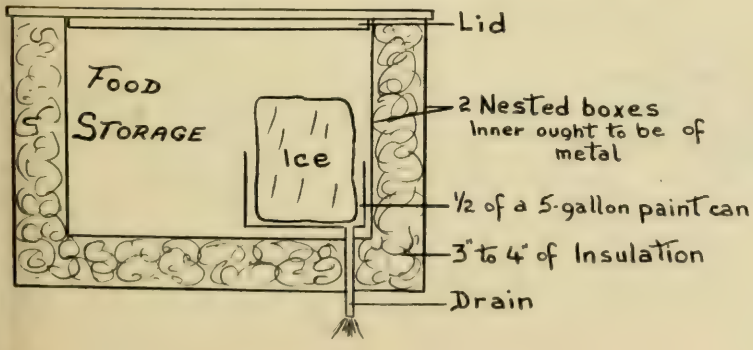


FIG. 20. (c) Cheap, temporary, household ice-box.

it is ideal for only a very few foods. Therefore those people who place milk, meat and eggs in a bucket and lower it into a well are getting about the same temperature and the same preservative effects as those who can afford the convenience of a box in the corner of the kitchen.

The temperature of ordinary house cellars and excavations called root cellars are controlled in part by ground temperatures. They tend to be warmer in winter and cooler in summer than above-ground air temperatures. We may yet cool our homes in summer by circulating part of the air in the home through pipes going deep into the ground.

Where most Canadians live there are at least five months of the year when average outdoor air temperatures are 40°F. or lower, and four to four and one-half months when temperatures in enclosed, insulated spaces can be accurately maintained at 32°F. by the judicious use of outside air. Considerable use is made of air-cooled food storages during the period from late fall to mid-spring, or from November the first to March the thirtieth, and very much greater use should be made of the winter air for such purposes. The principle of operation of such storages is simple and the larger they are the easier it is to maintain even temperatures. The building or room, if above ground, must be insulated with at least a four-inch thickness of a material with a "K" value of 0.3 or better. Closeable openings are provided at floor level on the rough basis of an opening eighteen inches by thirty inches for each one thousand cubic feet of space in the room. These act as air inlets if ceiling openings, air outlets (short chimneys), are provided. The latter should be about eighteen inches by twenty inches in cross section for each one thousand cubic feet of space and they must have

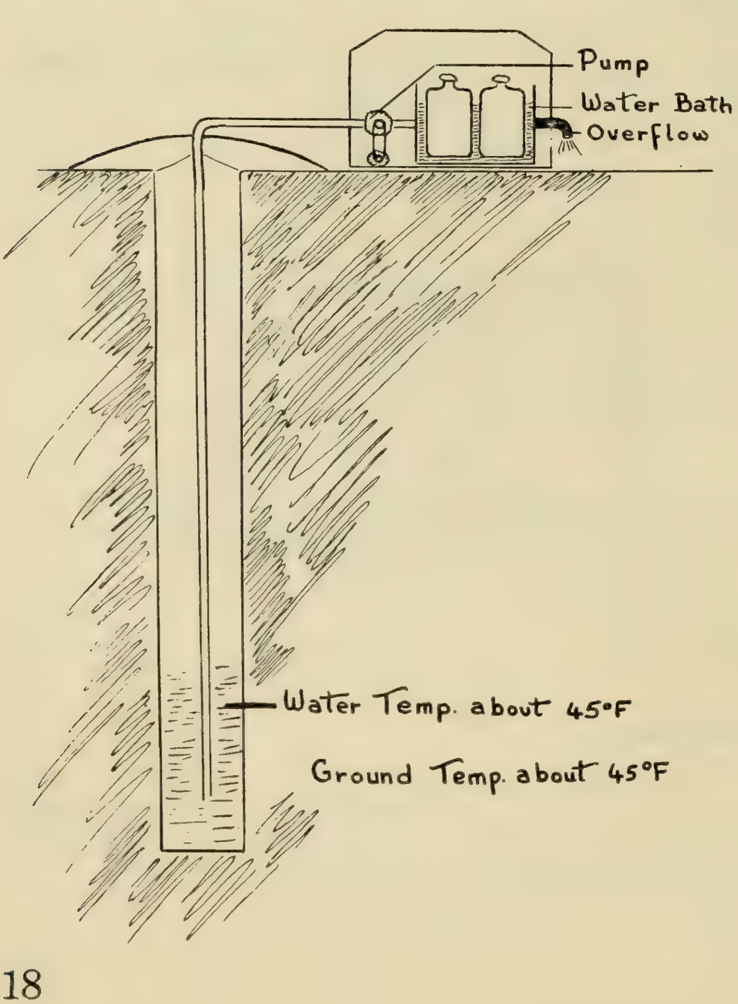


FIG. 21. One method of using the cool temperatures of deep soil levels is to use water from those levels. The year around temperature of such water is 40°F. to 45°F. if the well is protected in winter to keep colder air from flowing into it.

tightly fitted closures. When air-cooled storages are partially underground, insulation is applied only to the exposed parts. Cold air is allowed to enter at floor level through a duct, and warmer air is eliminated through a chimney. The sizes of air inlets and outlets are as described for above-ground storages.

Beginning with late harvested apples and such vegetables as potatoes, cabbage, beets, parsnips, carrots, turnips, winter radish and celery, the general procedure of running an air-cooled storage is as follows: materials harvested during the day are cooled during the night and the storage ventilation is opened during the night. Early in the morning the material is loaded into the storage and the storage is closed tightly. The day temperatures may be high, and the insulation of the storage must be good enough so that comparatively few heat units are able to get in. The procedure of night ventilation is kept up until the desired storage temperature is reached (ventilation can of course be used during the occasional cold day when outside temperatures are lower than those inside).

As the outside average temperatures drop lower as the season advances, only a small part of the ventilation system is used to maintain the desired temperature, and finally, outside average temperatures may be so low that the storage is kept tightly closed. Under these last conditions the desired storage temperatures may be considerably higher than the outside and heat units pass from the storage to the outside. But such losses of heat are held to reasonable quantities by the insulation and the "airtightness" of the storage construction. Even so, the temperature of the storage would drop were there no sources of heat units to replace those lost through the insulation. Heat is manufactured by the stored fruits and vegetables, and the greater the tonnage in the storage the more heat is produced. Some heat is also received from the ground under the storage, the latter being a large quantity when the storage is underground. Occasionally a small quantity of artificial heat must be added to balance gains with losses and thus keep temperatures level. But if the storage is properly insulated and heavily loaded with vegetables or fruits, artificial heat should not be necessary. Considerably more insulation would eliminate any necessity of artificial heat but it is usually cheaper to use a little heat for the comparatively brief periods of excessively low outside temperatures than it is to add excessive amounts of insulation to the original construction.

Some examples of air-cooled storage arrangements are shown in the self explained Figures 15 to 19. A simple ice-box is shown in Figure 20. A method of utilizing cold water is shown in Figure 21.

HUMIDITY

Heat ghosts cause water to evaporate into dry gas, which mixes with ir. If a lot of heat is allowed into water it may raise its temperature as vell, and if it is raised to about 212°F., evaporation of the water is very apid and the process is called "boiling". The point to remember is that vater vapour is a *dry* gas. Cooler air can hold less water vapour than can varmer air, and humidity of the air is reckoned not on the total weight of vater vapour in the air but on how much water vapour air of any given temperature can hold. Air at 70°F. must absorb much more water vapour than air at 32°F. if both are to become "full" (saturated) of water vapour (this combination is also called "100% relative humidity"). If air at say, 70°F., is carrying nearly a full load of moisture, and if that air is cooled by coming in contact with a cooler surface such as a ceiling or wall or the cooling system of a refrigerator, it cannot hold all of its water vapour. Some of the water vapour is deposited on the cool surface and as it accumulates becomes drops of ordinary, wet water ("sweating"). If a bulk of cold air is mixed quickly with warmer, humid air, a fog or mist or a cloud is formed of visible droplets of water. Further cooling causes the droplets to get together and fall as rain.

The drying power of air depends on how much water vapour it already holds in relation to how much it can hold. The last depends on its temperature. Air of 90% relative humidity has already absorbed 90% of what it is capable of holding at its present temperature. Such air has small capacity to "dry" things with which it comes in contact, and its relative humidity is said to be high.

If air is too dry for the comfort of people or for the retention of high quality in foods that it surrounds, water must be evaporated into the air. Steam, or a fine spray of water, are already almost water vapour and are often used to humidify air. Usually in food storages spreading water over the floor allows it to evaporate quickly enough to raise the humidity to the desired point. Some persons will set a bucket of water in a room to raise the humidity. They should realize that the water remaining in the pail is *not* raising the humidity. The same pail of water spread over the floor would become water vapour much more quickly.

The simplest way to lower the humidity of the air in a room is to eliminate the moist air and replace it with fresh, drier air from outside by opening ventilators temporarily. Or, if a rise in temperature will do no harm, merely adding heat to the air will lower its relative humidity and therefore render its effects "drier". Or, some of its moisture may be forced out on a cold surface. Or a chemical drier may be used. The last mentioned is well illustrated by the white salt (calcium chloride) used on roads to control dust. It has the power to take water vapour out of the air and thereby the salt becomes moist. If the air is in an enclosed space where it can't get more water vapour, the air is made drier by the salt.

PROPER STORAGE CONDITIONS FOR FOODS

Proper humidity for air in inhabited places is a matter for the medical profession to describe and for the air-conditioning engineers to produce. Proper humidity for air surrounding various foods is within the scope of this article and the generally accepted ideas on the matter are summarized in Table 2. Table 2 also includes recommended temperatures for the best storage of the more perishable foods.

TABLE 2

Recommended Storage Conditions for Raw Fruits

Fruit	Temperature Degs. F.	Humidity	Remarks
Pears	30-32	High (90%)	Always harvested *green* for storage-ripen at 65°F.-70°F.
Apples	32	High	Some varieties grown in some districts require higher temperatures.
Peaches	32	High	6 weeks storage is usually the limit.
Plums	32	High	6 weeks storage is usually the limit.
Berries	32	High	Store only a few days. Some exceptions such as green gooseberries.
Cherries	32	High	Short-lived in storage.
Grapefruit	50	High	Susceptible to low temperature injury.
Lemons			
Limes			
Oranges	32	High	Need frequent examination for rots.
Bananas	60	High	Ruined by comparatively short exposure to cool temperatures. Always harvested *green.*

(Store fruits in the common shipping packages never in bulk).

Recommended Storage Conditions for Raw Vegetables

Vegetables	Temperature Degs. F.	Humidity	Remarks
Turnip	32	Very high (90%-95%)	This group of vegetables will hold several months if in good condition when harvested, stored properly, and held to exacting temperatures and humidities. Cabbage must not be stored in bulk—use shelves. Celery is stored in special cases, or occasionally, small quantities are set upright in a few inches of soil.
Carrot			
Beets			
Parsnips			
Cabbage			
Winter Radish			
Kohl-rabi			
Leeks			
Celery			
Peppers	32	High	Susceptible to rots. May keep for 1-3 months.
Cauliflower	32	Very high	Unpredictable as to storage behavior.
Potatoes	38-40	High	Susceptible to low temperature injury. Will sprout in storage much more quickly at 45°F. than at 40°F. Therefore bins must not be larger than will allow the centre temperature to remain close to 40°F.
Onions	32	Low (65%)	The scales on the bulbs prevent undue water loss. Too high humidity encourages rots especially in the neck area. Must not be stored in bulk.
Tomatoes	50-55	High	Successful storage for 30 days is exceptional and the tomatoes must be slightly ripe at harvest for long storage.
Pumpkin	50-55	Low	Variable in storage life according to variety and the onset of rots.
Squash			
Radish	32	Very high	All of these vegetables are short-lived in storage. None will stand bulk storage. Clean, cracked ice mixed with them helps to hold a satisfactory temperature and humidity.
Lettuce			
Corn-on-cob			
Asparagus			
pinach			
Green Onions			
Cress			
Parsley			

NOTE: If a large quantity of any fruit or vegetable is stored, inquiry should be made for full directions. Only a few salient points can be given here.

Recommended Storage Conditions for Miscellaneous Foods

Foods	Temperature Degs. F.	Humidity	Remarks
Meat	32	"Medium"	Flesh will shrink seriously in too dry an atmosphere. Too high a humidity may result in the formation of bacterial slime on the surface. The surface must be allowed to dry after slaughter operations.
Fish			
Fowl			
Milk	32	—	Should be closely covered for cleanliness and prevention of odour absorption.
Cream			
Butter			
Eggs	31-32	"Medium"	Eggs lose water quickly in a dry storage atmosphere. If too much moisture is present they may develop "whiskers" or mould growth. Keep the humidity as high as is consistent with keeping mould growth in check.
Cooked Foods.			32°F. will slow bacterial growth better than a higher temperature. 40°F. is the highest temperature which offers fairly adequate protection from those organisms responsible for food poisoning. Use the lowest temperature available and use it promptly. Low temperatures help to hold some of the vitamins.

Frozen Foods

No food (except water) will freeze at 32°F. Most foods will freeze at some temperature between 26°F. and 30°F. But there is still too much heat in them to keep well.

Modern quick-frozen foods are frozen at temperatures below 0°F. and are held for long storage at not higher than 0°F. Frozen foods may be held for short periods in the freezer compartment of a household refrigerator so long as they remain frozen. They should be eaten immediately after defrosting for best quality. Complete instructions are available in the Ontario Department of Agriculture Bulletin No. 412.

Meats and butter are often held at freezing temperatures above 0°F. but deleterious change go on more slowly at lower freezing temperatures. The not uncommon belief that frozen foods keep indefinitely is completely erroneous.

Miscellaneous Remarks Concerning Food Storages

1. Recommended temperatures and humidities have the same effects on foods regardless of how these conditions are obtained.

2. A storage ceiling that condenses water and causes dripping needs more insulation.

3. Moving air is what keeps temperatures more or less uniform throughout a storage room. Foods must be packed and stacked in such a manner that air can circulate freely up the walls and across the floor and ceiling and through the stacks of food.

4. Accurately held temperatures are essential for the longest possible storage of food kept in the best possible condition. If a food keeps best at 32°F. it will only keep from one-half to one-quarter as long at 40°F.

5. High relative humidity does not wet foods and most foods must be kept from drying out. Fluctuations of temperatures as a result of carelessness or defective installations can cause precipitation of water on foods.

6. Rapidly moving air has a greater drying power than slowly moving air of the same relative humidity. Fans used to help maintain even temperatures by forcible circulation of the air should not be directed at the foods in the storage.

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EGGS

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THE PRODUCTION, IDENTIFICATION AND RETENTION OF QUALITY IN EGGS

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INTRODUCTION

Eggs have long held an important place in the human diet. They were easy to prepare for food and people liked them; thus a more or less satisfactory market was always available. Competition among foods was also relatively mild and thus the availability of eggs, price and their attractiveness of appearance were the main factors influencing their use.

Recent nutritional investigations have, however, changed all this. The housewife has become food conscious. Foods are now carefully evaluated before purchase; their vitamin and mineral content studied. The quality of protein, amount and digestibility of the fat and the ease and economy of preparation are matters of great importance. Flavours are delicately tested and even fitness in the meal's colour scheme is a matter of moment. Result—a keen competition in the use of foods, dependent on their nutritional and other values. In this competition eggs are not exempt.

Science has, however, assigned eggs a leading role nutritionally, and the importance attached to their use in the diets of both the Armed Forces and civilians during the war has confirmed that role. Nutritionists advise an egg a day or 30 dozen per year per capita for optimum nutrition. Canadian consumption is good and is increasing, having risen 3.27 dozen per capita between 1939 and 1945. At 23.37 dozen in 1945 there is, however, still considerable room for improvement. The possibilities for future increase are a matter of conjecture.

Canada is fortunate in its possession of a highly developed poultry industry. Being largely an agricultural country, there is usually an abundance of coarse grains and their by-products and also green feeds. In normal times there is also an abundance of animal by-products. This makes the feeding of balanced rations easily possible. Advanced, widely applied breeding policies, aided by a well-organized and responsible hatchery industry, make superior laying stock readily available, and such stock is largely used. Uniform grading regulations with provision for producer grading, the application of which regulations is facilitated through an extensive system of registered egg grading stations, make it possible to satisfactorily meet the demands and needs of the consumer.

Due to the tremendous and urgent demand during the war for eggs for Britain, for the Armed Forces and increased home use, Canadian farmers and poultrymen have greatly increased their flocks to meet this need. The following table indicates the extent of this expansion.

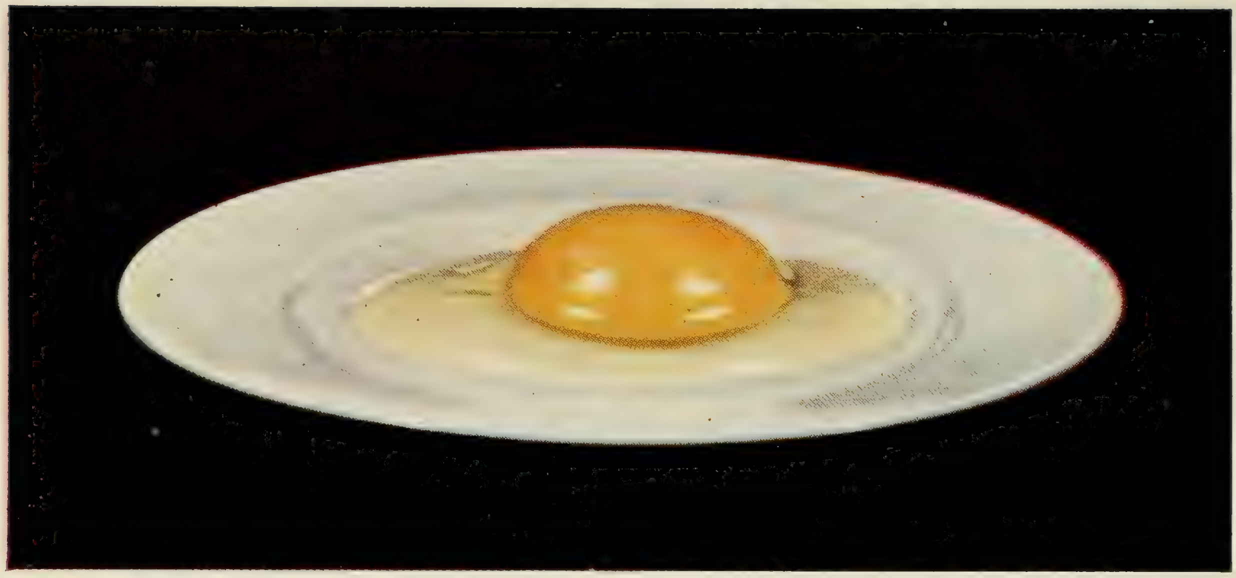


FIG. 1. **Few foods are more appetizing than an A grade egg with its attractive yolk colour, high percentage of thick white and mild, delicate flavour.**

TABLE I.—RECEIPTS OF EGGS FOR BRITAIN INSPECTED BY SPECIAL PRODUCTS BOARD

1939 . .	34,394 cases of 30 dozen each	1943 . .	1,121,427 cases of 30 dozen each
1940 . .	355,910 cases of 30 dozen each	1944 . .	2,664,325 cases of 30 dozen each
1941 . .	519,357 cases of 30 dozen each	1945 . .	2,998,170 cases of 30 dozen each
1942 . .	1,251,198 cases of 30 dozen each	1946 . .	1,896,834 cases of 30 dozen each

According to the Quarterly Bulletin of Agricultural Statistics, the poultry situation in Canada as to production and domestic consumption of both eggs and poultry is as follows:

TABLE 2

Year	No. of Hens	Total Dozens Production	Production per Bird	Price per Doz.	Consumption per capita	
					Eggs (doz.)	Poultry (lb.)
1939....	24,024,000	221,737,000	111	18.5	20.10	19.49
1940....	26,420,000	235,322,000	111	19.5	20.20	20.50
1941....	25,874,000	244,157,000	113	21.4	20.35	19.53
1942....	29,236,000	280,253,000	115	29.0	22.05	23.52
1943....	32,725,000	315,027,000	116	31.9	23.69	22.72
1944....	37,245,000	360,948,000	116	29.4	24.40	26.32
1945....	37,929,000	373,952,000	118	32.0	23.37	26 62
Increase 1945 over 1939						
percent	57.9	68.6	6.3	72.9	16.2	36.6
units	13,905,000	152,215,000	7 eggs	13.5	3 27 dozen	7.13 pounds

In Ontario the poultry population has increased rapidly and has contributed extensively to the total Canadian increase to which we have already referred. From an estimated 7,946,000 laying hens in 1940 the total has risen to 11,457,000 in 1945 with an estimated production of 119,344,000 dozen eggs. Other Provinces have made similar progress.

Several conditions seem apparent. Producers and consumers alike need to know all available information concerning eggs. They should realize their high nutritional value and the factors influencing such values. They should also understand all factors and conditions in the production and marketing of eggs which influence quality in any way. Such knowledge should aid consumers in making maximum use of the product. It should also aid producers to so intelligently produce a maximum quality product as to enable them to successfully meet competition, whether nutritional or economic and to maintain and develop a stable remunerative poultry industry in Canada. The material in this bulletin is offered as an aid to this end.

FIG. 2. Clean eggs, sound in shell and uniform in size and colour, arouse interest and encourage consumption.

WHAT IS AN EGG ?

The egg is an amazing phenomenon; it is also one of nature's outstanding foods and is the sole source of the nutrients needed to develop a healthy, lusty chick and to completely nourish that same chick for the first several days of its active life. This means that within its shell is contained all the food ingredients, perfectly balanced, for the developing chick. It also means that this same egg, when consumed by man, may, in his diet, be a very important source of balanced food of the highest quality.

When to its high nutritional value is added an attractive and appetizing appearance, great versatility of use in cookery practice and a high degree of digestibility, then one has a food of merit. To cap the climax, this food is usually practically sterile when laid, and is surrounded by a shell for protection and ease in handling.

THE FOOD VALUE OF EGGS

The importance of eggs as a food is based on several factors:

(1) **Eggs are a Protective Food**—Eggs, milk, fruits, vegetables and some red and glandular meats are classed by nutritionists as "protective foods." Why? Because:

They are rich in well-balanced proteins.
They are rich in vitamins.
They are an important source of essential minerals.

Protective foods are so called because of their ability to balance diets commonly over-rich in starches, sugars and fats and too frequently lacking in balanced proteins, minerals and vitamins.

Well controlled animal experiments have demonstrated that the liberal use of protective foods will:[1]

(a) Give better support for the mother and a better start in life for the young.
(b) Speed up maturity and produce better development.
(c) Produce a high level of adult vigour.
(d) Extend the average useful span of life.

Protective foods are a vital factor in the rearing of Canadians with strong healthy bodies and alert minds, therefore their extensive use in the Canadian diet is amply justified. Eggs are one of the protective foods.

(2) **Eggs are Rich in High Quality Proteins**—Egg protein is unique in that it is rich in all of the ten amino acids considered indispensable for growth, tissue repair and other body functions. Because of this it is called a balanced protein. This also makes it valuable for balancing deficiencies in proteins which lack essential amino acids. In this respect it is similar to the protein of milk. Egg protein is usually easily and almost completely utilized. Because of the destruction of a certain protein (avidin) which in the uncooked state makes biotin (a necessary vitamin) unavailable, cooked egg white is somewhat more digestible than when used raw. It may, however, be materially lowered in digestibility if overcooked, in which case it becomes hard and rubbery. Egg yolk protein is little injured, if at all, by cooking.

(3) **Eggs are Rich in Easily Digested Fat**—This fat is colloidally dispersed or is in what might be called an emulsified form which renders it readily digestible not only by adults but even by children as young as three months of age. This is true of few other fats. Egg fat is rich in phosphorus and in essential fatty acids. It is also the carrier of many of the vitamins present in the egg.

(4) **Eggs are an Excellent Source of Vitamins**—This is particularly true of vitamins A, D and riboflavin. One group of investigators has stated that "no other animal tissue approaches the egg yolk as a source of vitamin A except liver, which is generally more than twice as rich, weight for weight, as egg yolk."[1] As a natural source of vitamin D, egg yolk is second only to fish liver oils. It is also a good source of riboflavin (vitamin G) which is the only vitamin found in appreciable amount in egg white. Egg yolk is also a useful source of thiamin (B_1), niacin, pantothenic acid and vitamin E and a fair source of certain essential fat acids, vitamin H (or biotin), vitamin D, choline and probably vitamin B_6 and other vitamins or vitamin-like compounds. In fact eggs contain most of the known vitamins with the notable exception of vitamin C.[2]

It is important to bear in mind that the amounts of the various vitamins contained in eggs may vary considerably, dependent on the vitamin content of the feed fed to the laying stock.

(5) **Eggs are Important Sources of Minerals**—The iron content of the eggs is relatively high in comparison with other foods and is in a readily available form. Most of the iron is stored in the yolk. Eggs are also a source of calcium and are rich in phosphorus. Copper, iodine, and a number of other minerals are also present in useful amounts. The feeding of cod liver oil has been shown to increase the iron and copper content of eggs as well as that of vitamin D[3] and there is also evidence that breeding is a factor in the iron content of individual bird's eggs.

(6) **Eggs are Palatable and Useful in Special Diets**—Most people like eggs in some form or other, especially if attractive in appearance and mild in flavour. As already stated elsewhere, eggs are highly digestible, especially when not over-cooked. Physicians frequently prescribe eggs in the diets of invalids and in the treatment of a number of ailments. Eggs are excellent in the diet of the pregnant mother and growing child.

(7) **Eggs are Almost Indispensable in Cookery Practice**—Eggs are adaptable in cookery. Served either alone or combined with other foods,

which they often serve to enrich, they are palatable and attractive. They have a leavening effect in making cakes and omelettes; they prevent the clustering of ice crystals and so their use results in smooth textured ice cream. Their emulsifying properties are important in mayonnaise dressing; they also serve to thicken custards, gravies and sauces. They serve as a binding agent in meat loaves and adhere crumbs to chops and fish in breading. Sliced, diced or minced they serve as a decorative agent and when added to coffee they serve to clarify. It is for these reasons that they are considered so necessary in cookery practice.

TABLE 3 — WHAT EGGS CONTRIBUTE TO OUR DAILY FOOD REQUIREMENTS*

Food Nutrients	**One Egg Contains**	**% of Daily Requirement for Average Adult One Egg Supplies**
Protein	6.7 grams	10%
Calories	70.0	2- 3%
Calcium	0.03 grams	4%
Phosphorus	0.11 grams	9%
Iron	1.55 mg	13%
Vitamin A	200- 800 I.U	4-16%
Thiamin (B_1)	60- 120 mcg	3- 6%
Vitamin D	10- 50 I.U	3-12%
Riboflavin	100- 500 mcg	3- 7%
Niacin	760 mcg	3- 4%
Pantothenic Acid	600-1200 mcg	6-12%

* R. V. Boucher, Pennsylvania State College.

Thus a single egg supplies from 3 to 16 per cent of the daily requirement of all except one of the nine essential nutrients that are most likely to be deficient in the average human diet. The missing nutrient, vitamin C, is found plentifully in most vegetables and fruits.

It is for these and other well authenticated reasons that in Canada's Official Food Rules in the Canadian Nutritional Program, eggs are listed along with milk, fruits, vegetables, cereals and bread, meat and fish as "health protective foods." Adequate consumption of these is urged and the daily requirement of each for good nutrition is stated. The recommendation for eggs is "at least 3 or 4 weekly" with the added injunction for all of the above to "be sure to eat them every day in at least these amounts and more if one can." This program was prepared by the Nutrition Services of the Department of National Health and Welfare and approved by the Canadian Council of Nutrition. On the advice of Dr. Frederick F. Tisdall and his associates in charge of the R.C.A.F. nutritional program, 6 to 12 eggs per week per man were regularly included in the rations while in training. Somewhat similar allowances were included in the Army and Navy rations.

The following statement by Harry W. Titus, Senior Biological Chemist of the U.S. Department of Agriculture will serve well to summarize the food value of eggs.[2]

"Eggs are an important protective food. They are a fair to good source of most of the known vitamins and vitamin-like factors; they contain a good assortment of the mineral elements; they are a rich source of protein of high biological value and their fat is of unusual nutritive value.

"The nutritive value of an egg is independent of the colour of its shell. Eggs have a high coefficient of digestibility and a fairly high satiety value."

Certain properties make them of value in upbuilding diets. "Among these are their low content of sugar, the high biological value of their protein, their negligible content of purines, the availability of their iron for the formation of hemoglobin, and their high digestibility and utilization, which cause eggs to be classed among the low residue foods."

WAYS IN WHICH EGGS MAY BE MERCHANDISED

Eggs are most commonly merchandised in any of several forms:

(1) **In the Shell**—The original and most common. In this form they are readily handled and attractive in appearance. The shell affords considerable protection from outside contaminating contacts and serves as a useful individual package until the contents are consumed. It also facilitates handling in quantity in cartons and crates and is an aid in storage. All commercial grading is done while eggs are in this form.

(2) **Broken Out and Frozen**—Frozen egg meats, as whole eggs or with the yolks and whites separated, are extensively used; particularly in the baking, ice cream, candy and mayonnaise dressing trades. Stored in special containers such egg material keeps for a year or more with a minimum loss of food value and great saving of storage space. This broken out egg material is known in the trade as egg melange.

(3) **Dried or Powdered**—The practice of drying eggs has been greatly perfected during the war and is extensively used by Canada as well as the United States and several other countries. Dried eggs have been of inestimable value to the people of Britain and the Allied Armies. They are also a boon to the people of the liberated countries of Europe. Quality eggs, correct temperatures, and extreme sanitation are essentials in the preparation of a first-grade egg powder. Such an egg powder has fine flavour, a low bacterial count, high solubility, and a very low moisture content. By packing it in vapour-proof containers this quality can be retained more or less indefinitely. Preparation under proper facilities and according to up-to-date practice results in minimum loss of food value, and separate drying of whole egg meats, whites and yolks makes possible many uses. The addition of water or milk enables the preparation of scrambled eggs, omelette, custards and numerous other dishes. The powder is also extensively used in the prepared flour, baking, ice cream, candy and other industries.

Thirty-three percent of sugar, added during the drying process results in "sugar dried" egg preferred by British bakers for their greater "lift" when used in pastries. Practically all Canadian egg powder now exported to Britain is of the "sugar dried" type.

QUALITY DEFINED

Not all eggs are of the best quality, not even when freshly laid. Many factors influence quality; some prior to laying and others in the interval between production and consumption.

What is Egg Quality?—It may be defined as those conditions in an egg which:

(a) Make the egg most attractive in appearance to the consumer, both in the shell and broken out, and both raw and cooked.

(b) Render the egg of the highest nutritional value.

Commercially a good egg is one, preferably infertile, that has a clean, sound shell, attractive broken out appearance, and a fine, mild flavour. For maximum nutritional value, however, the eggs must be from hens in the best condition and fed on a ration rich in minerals, vitamins and high quality proteins, such as found in a hatching ration. This may, however, be uneconomical unless a special price can be procured for eggs produced from this more expensive ration.

The following tables illustrate two examples of the effect on the vitamin content of eggs brought about by additions of such vitamins to the ration.

TABLE 4—THE EFFECT OF DIET ON THE VITAMIN D CONTENT OF EGG YOLK†

	International Units (I.U.) per average egg yolk
Basal	10.26
Basal + 2% Cod Liver Oil	81.0
Basal + 2% 5X (fortified) Cod Liver Oil	153.9

†Branion, Tisdall and Drake

Eggs with as much as 48,600 I.U. of vitamin D were produced when 2% of a very concentrated form of vitamin D carrier was fed. This is, however, uneconomical.

TABLE 5—THE EFFECT OF DIET ON THE VITAMIN A CONTENT OF EGG YOLK

Diet	Eggs Laid in 100 Days	No. of Eggs Analyzed	Vitamin A Per Gram Yolk	Vitamin A Per Yolk	
			In Micrograms		Range
Basal	44	8	6.6	112	(89-133)
Basal + .25% C.L. Oil	58	8	7.1	124	(89-200)
Basal + .50% C.L. Oil	76	8	7.8	146	(105-195)
Basal + 1.00% C.L. Oil	74	8	8.5	155	(106-214)
Basal + 2.00% C.L. Oil	74	8	9.2	170	(136-235)

University of Wisconsin 1939

Infertile Eggs—Infertile eggs produced from good diets have equal nutritional value and in addition will keep better under adverse conditions of temperature than will fertile eggs.

HOW CAN EGG QUALITY BE RECOGNIZED?

(a) The egg may be candled. This is the commercial method and a good one, though not perfect. The type of "candle" used, as well as the eye-sight, alertness, experience, and judgment of the operator are all important factors in efficient candling.

(b) The egg may be broken out of the shell, examined and smelled for odours. This is done where the eggs are to be either dried or frozen as melange, or where they are to be used at once as food.

(c) Quality may also be judged by cooking, baking and whipping tests and by odour and taste.

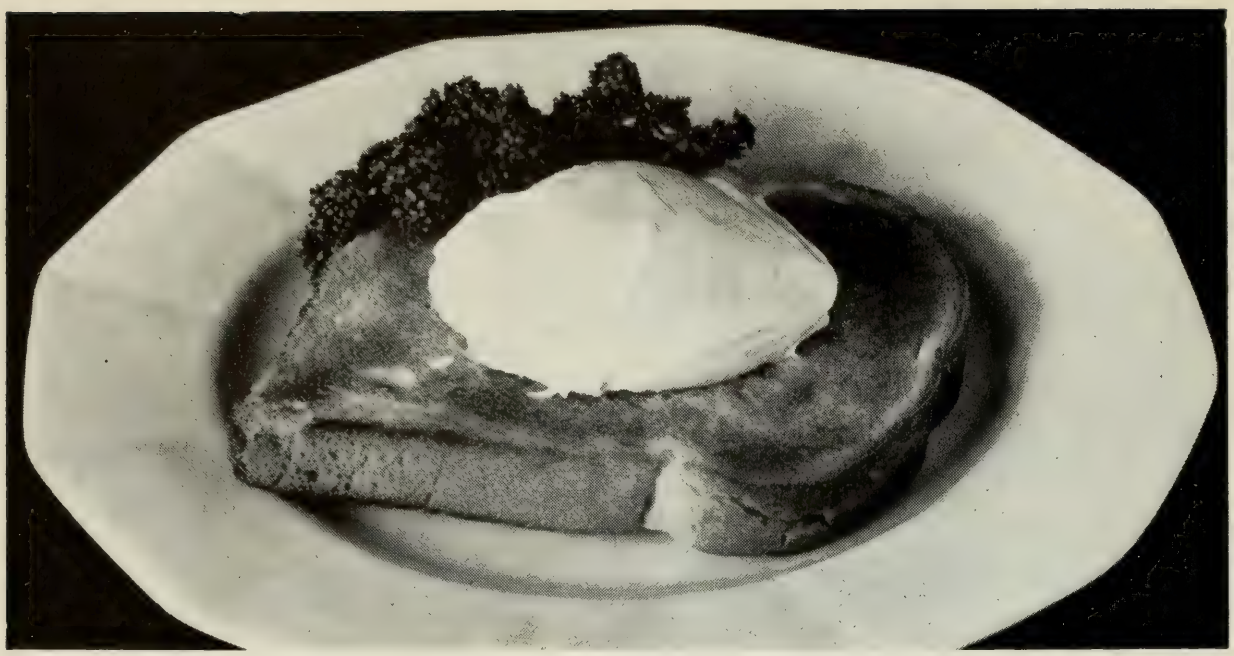


FIG. 3. High quality poaching egg (Grade A).

There are few foods more tempting or satisfying than a perfectly poached egg, attractively served. A poached egg, unbroken and firm, yet delicate and jelly-like in texture is an achievement. The method of cooking is important but the quality of the egg to be poached is equally, if not more, important.

For best results the egg must be of good flavour and the colour of both yolk and white attractive. The yolk must be well rounded (not flattened) and have a strong yolk-membrane. The white must be thick and cling close to the yolk. An egg with a thin, watery white never poaches well. Thus, poaching is a test of quality.

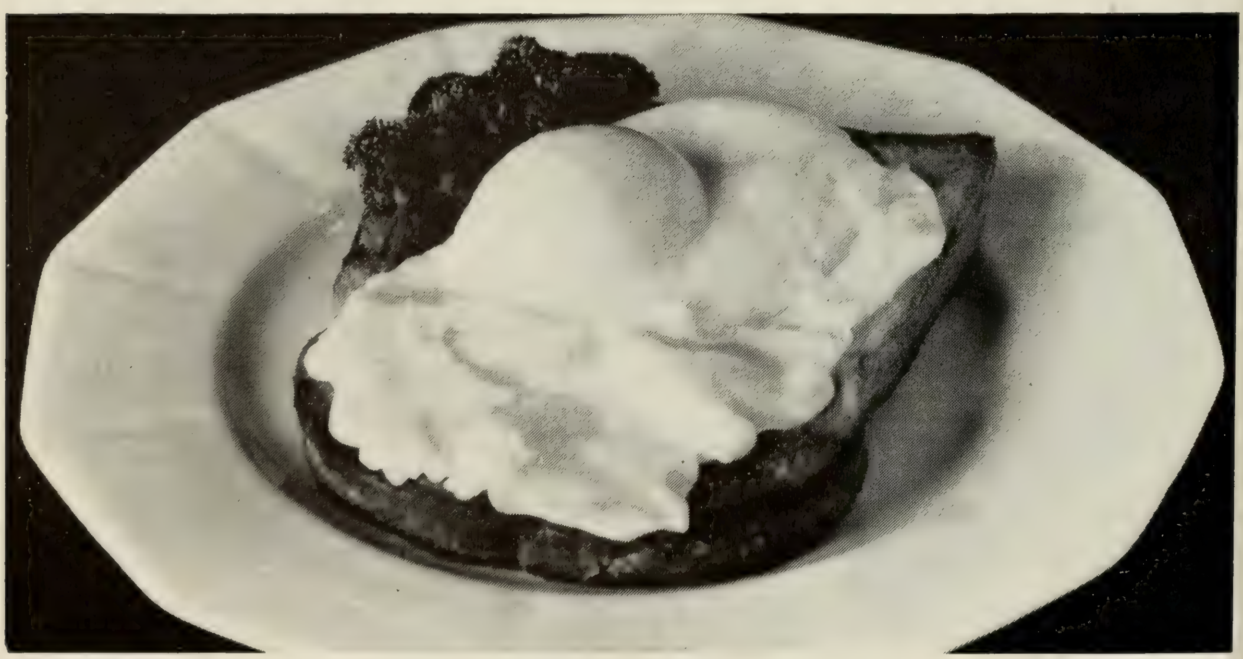


FIG. 4. Medium quality poaching egg (Grade B).

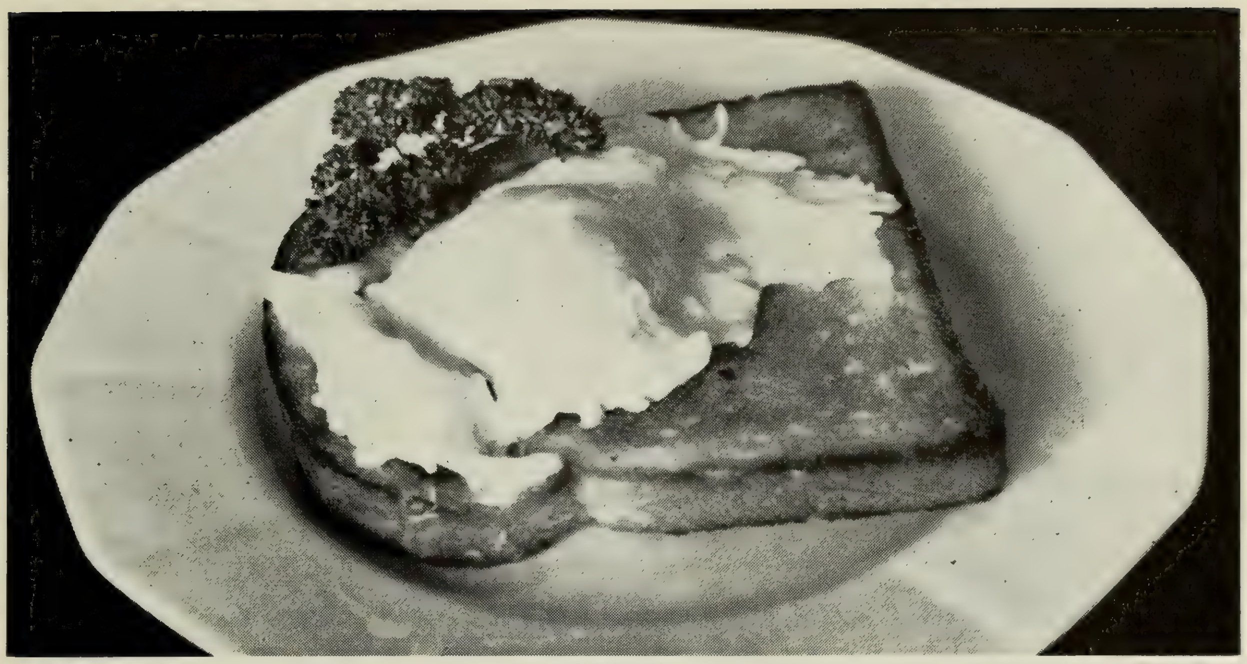


FIG. 5. Poor quality poaching egg (Grade C).

REASONS FOR PURCHASE OF EGGS ON GRADE

The best means by which the customer may be assured good eggs is by purchase on grade. Two main objectives are accomplished by this:

(a) The grade of egg most suitable for the purpose desired is secured.

(b) Economy is easily possible with a minimum sacrifice of food value.

The higher grades are needed for poaching and other purposes where only the best eggs are satisfactory, while the lower grades are suitable for cooking, baking and similar uses.

Grading also remunerates the producer on the basis of the quality produced.

BASES ON WHICH CANADIAN EGGS ARE GRADED[4]

(a) The Size Factor—into large, medium and pullet sizes within the grade.

(b) The Appearance Factor—Grade A1 and Grade A eggs are spotless, while slightly soiled or soiled eggs grade B and C respectively.

(c) The Shell Factor—A poor shell is difficult to handle and results in more rapid spoilage—hence is C grade, especially if cracked.

(d) The Quality Factor—This involves the size of air space; the position, shape, movement and visibility of the yolk shadow when candled; also the thickness of the white and the absence of any germ development and abnormalities such as meat and blood spots.

Every Ontario producer and consumer should be familiar with Canadian Egg grades and their requirements, and should sell and purchase respectively only on a graded basis. Grading protects both the producer and the consumer and engenders confidence, mutual respect and good will in merchandising.

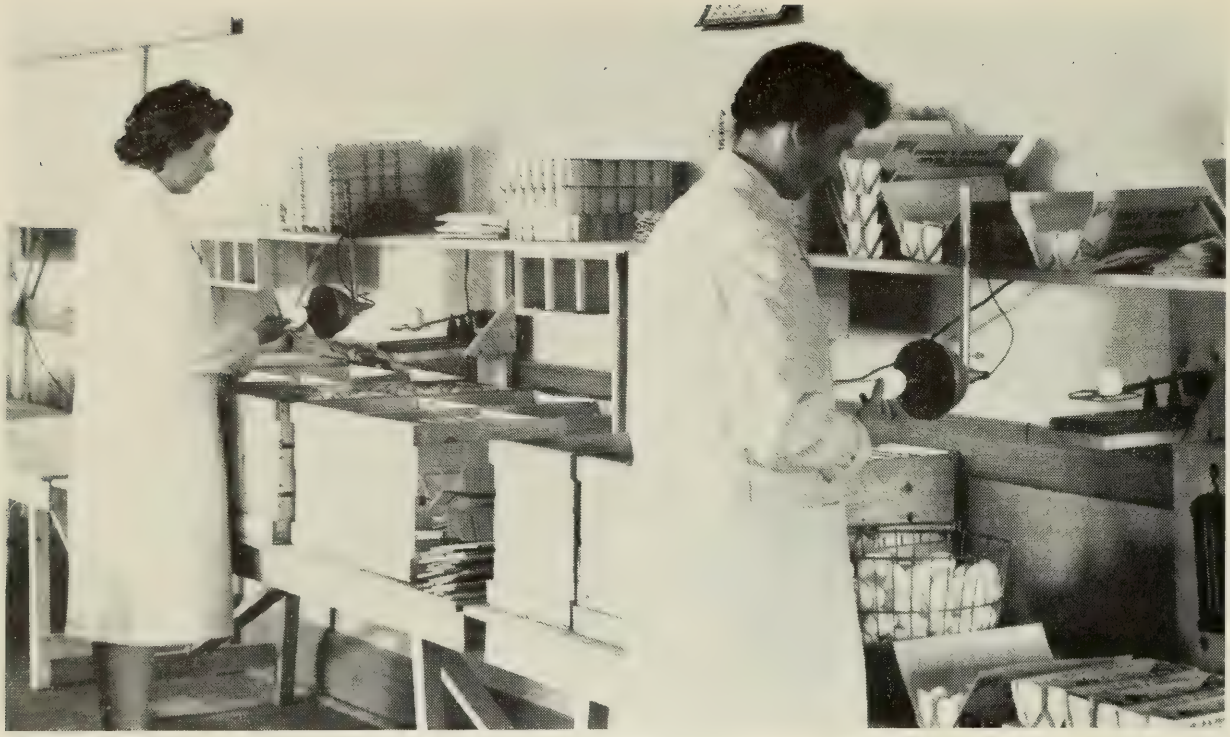


FIG. 6. Set-up and equipment suitable for grading and packing eggs either in cases or in cartons.

In Ontario and throughout Canada are numerous strategically located Registered Egg Grading Stations. These are equipped to handle and grade the producers' eggs rapidly, accurately and economically. Modern candling lamps and mechanical grading machines are an aid. Cleanliness and controlled optimum temperature and humidity are required by Federal authority as an aid in retaining original quality. Thus, producers and consumers alike are afforded protection.

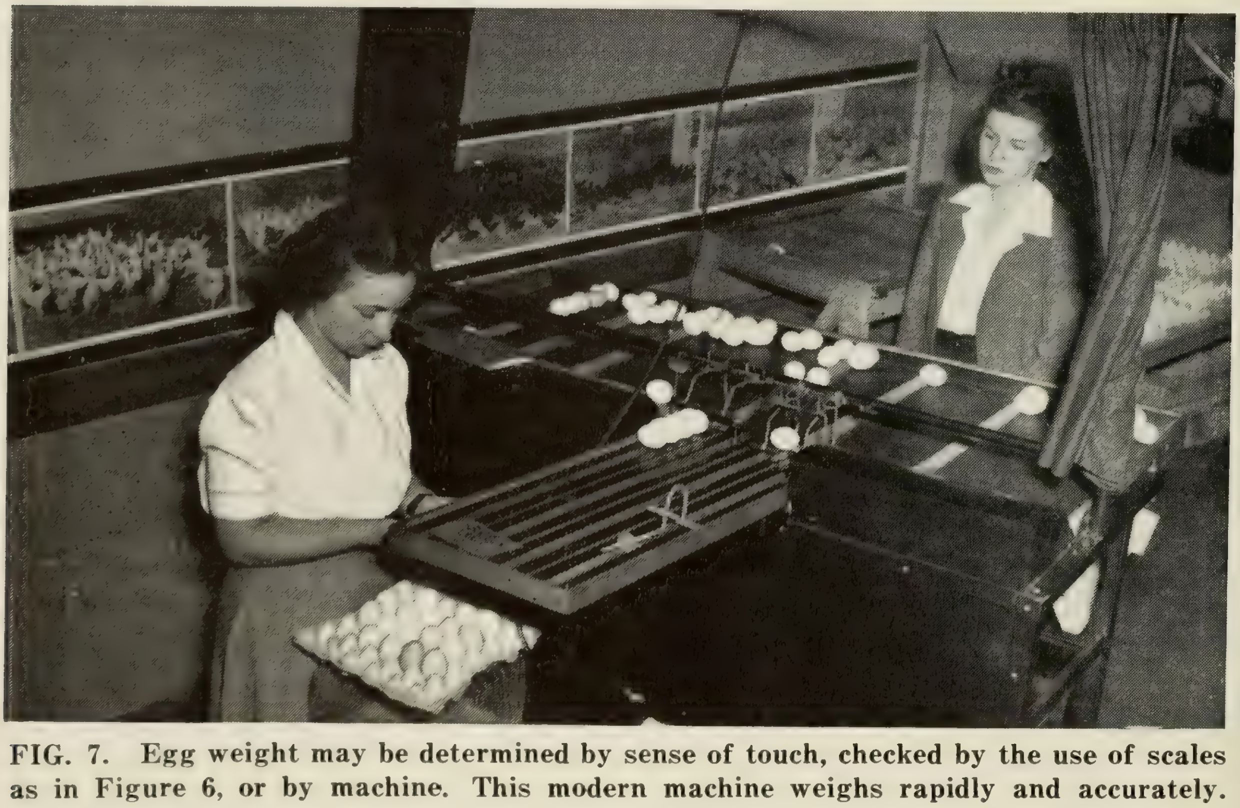


FIG. 7. Egg weight may be determined by sense of touch, checked by the use of scales as in Figure 6, or by machine. This modern machine weighs rapidly and accurately.

TABLE 6 — THE CHIEF SPECIFICATIONS OF THE CANADIAN EGG GRADES[4]

	Shell and Grade Appearance Factors	Weight Per Dozen	Air Cell	Yolk Condition	Undergrades at Point of Shipment	Miscellaneous
A 1	Clean. No spots or stains. Sound. Regular in construction. No cracks or checks.	Large — 24 oz. + Medium—22-24 oz. Pullet — 20-22 oz.	Not to exceed ⅛ inch in depth.	Yolk shadow indistinct, small and round in shape. Well centred. No mottled yolks, grass yolks, germ spots, meat or blood spots allowed.	Not more than 8 undergrades per 15 dozen.	Packed only by producers and producers' organizations authorized by the Dominion Government.
A	Clean. No spots or stains. Sound, regular. No cracks or checks.	Large — 24 oz. + Medium—22-24 oz. Pullet — 18-22 oz.	Not to exceed $\frac{3}{16}$ inch in depth.	Yolk outline indistinct. Reasonably small and round in shape. Well centred. No mottled yolks, grass yolks, germ spots or meat or blood spots allowed.	Not more than 8 undergrades per 15 dozen.	Fresh eggs. Best commercial grade.
B	May show slight stains and small spots. Sound. No cracks or checks.	Large — 24 oz. + Medium—22-24 oz. Pullet — 20-22 oz. When commercially packed at one weight —no individual egg below 22 oz. per dozen allowed.	Not to exceed ⅜ inch in depth. No floating air cells.	Yolk outline may be slightly visible, yolk shadow slightly oblong but not definitely enlarged or flattened. Yolk—not at top of egg. Must float freely on twirling. No extremely mottled or grass yolks, pronounced germ spots, blood or meat spots allowed.	Not more than 8 undergrades per 15 dozen.	Cold stored eggs included in this grade.
C	May be dirty or stained. May be cracked or irregular. Cracked eggs packed separately and marked: "Grade C Cracks"	No minimum weight. Note: In Grades A-1, A and B, individual eggs must be up to minimum weight, and up to but not including maximum weight in each weight bracket.	No maximum air cell size.	Outline may be distinctly visible, **but** No yolks adhering to shells. No broken yolk membrane allowed. Extremely mottled yolks, grass yolks, pronounced germ spots and meat spots allowed.	Not more than 8 undergrades per 15 dozen.	Cold stored, small and held eggs included in this grade.

STRUCTURE OF THE EGG

The egg is comprised of five main parts, namely, the shell, the two shell membranes, the white, the yolk and the germ spot or germinal vescicle.

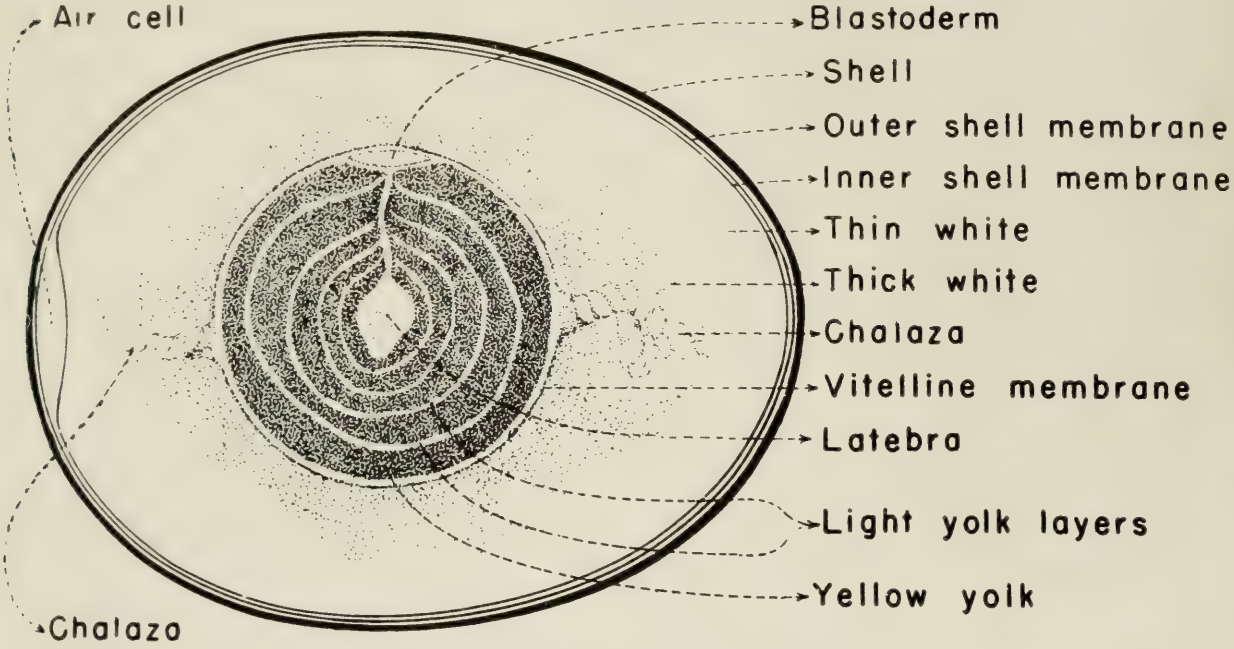


FIG. 8. Structure of an egg.

The Shell—The shell with adhering membranes consists of the mam- the spongy layer (the outermost) being the thicker and comprising about shell membranes.

The Shell Layers—The mammilla and spongy layers consist respectively of differently shaped and arranged particles of calcium carbonate, the spongy layer (the outermost) being the thicker and comprising about two-thirds of the total shell thickness.

Pores and Cuticle or Bloom—The pores are more or less irregular minute openings in the shell serving for the purpose of gas interchange during incubation; while the cuticle or bloom, a protein material known as keratin, covers the outside of the shell and, in a freshly laid egg, closes the pores. The reaction of carbon dioxide (CO_2) escaping from the egg with water vapour in the air, serves to gradually dissolve the bloom, thus allowing evaporation of moisture through the pores of the shell when the egg is held or stored.

The Shell is Fragile—The purpose of the shell is to give protection to the fertilized egg and its surrounding food supply during incubation. In this function it is usually efficient and its porosity allows for needed gas interchange for the developing embryo.

The shell was, however, never intended for commercial use. It is not constructed to withstand the rough handling to which it is often subjected in commerce, and its many pores allow for rapid evaporation and also for

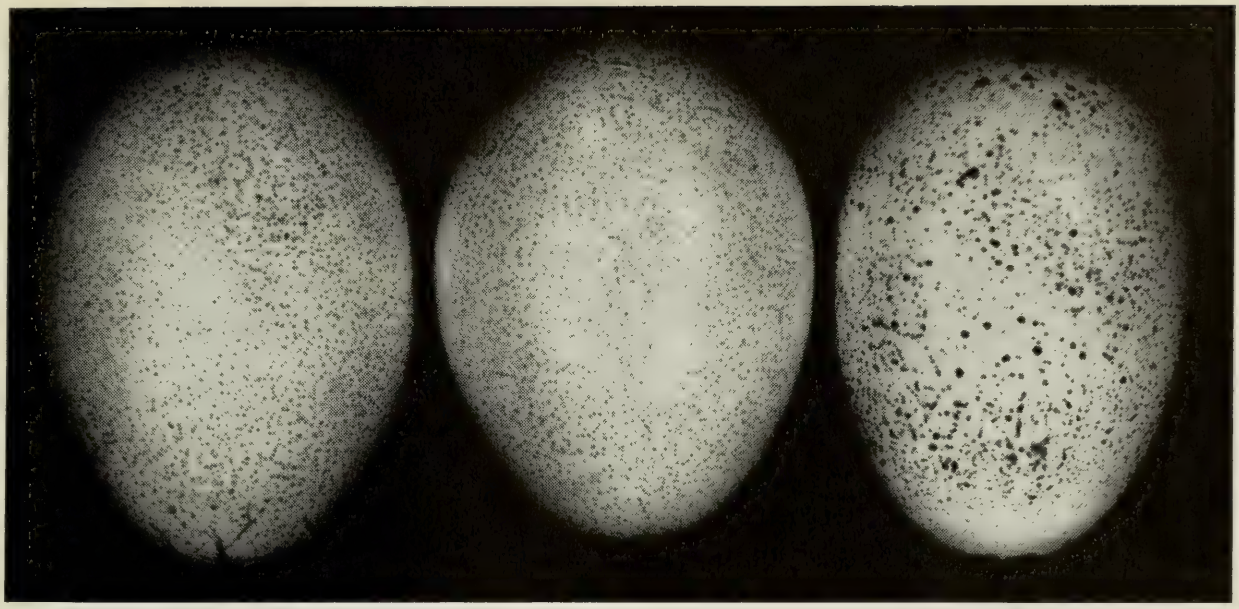


FIG. 9. Two strong, dense shells and a weak, porous one. The shells were scraped on the inside and filled with dye. The dye working through made the location of the pores plainly visible. The larger pores and the more open structure of the weak-shelled egg allowed the dye to work through more readily. There are from about 6,000 to 8,000 pores in an average egg shell. There is a definite tendency for the air space to increase more rapidly in a thin, weak shelled egg because of greater evaporation from the larger pores in the shell of such an egg.

absorption of undesirable odours. It is for these reasons that eggs should be handled gently and should at all times be kept clean and away from musty conditions and pronounced odours.

TABLE 7—COMPOSITION OF THE EGG SHELL

$CaCO_3$ (Calcium)	93.7 %
$MgCO_3$ (Magnesium)	1.39 %
P_2O_5 (Phosphorus)	.76 %
Organic Matter	4.15 %

G. F. Stewart, Cornell Univ. 1935.

Shell Colour—Shell colour is dependent on the presence of pigment-secreting glands or mechanism among the shell secreting glands of the uterus, that part of the oviduct in which the shell is formed. Breeds and varieties laying white shelled eggs lack this mechanism, hence the calcium carbonate of which the shell is chiefly composed is chalk white. In breeds laying coloured shells, the intensity of colour probably depends on the number, kind and activity of pigment-secreting glands present in the uterus of the individual bird. It should be emphasized that shell colour has no connection with either flavour, nutritional values or keeping qualities of eggs.

Shell Membranes—The shell membranes each consist of a more or less unorganized matrix of organic fibres. The two membranes adhere closely and together line the inside of the shell. Following laying, cooling of the egg results in contraction of the contents. This creates a slight vacuum and results in the parting of the shell membranes usually at the large end of the egg, thus producing the air space which increases in size as evaporation of the egg contents takes place. The shell membranes are not impervious either to gasses or micro-organisms.

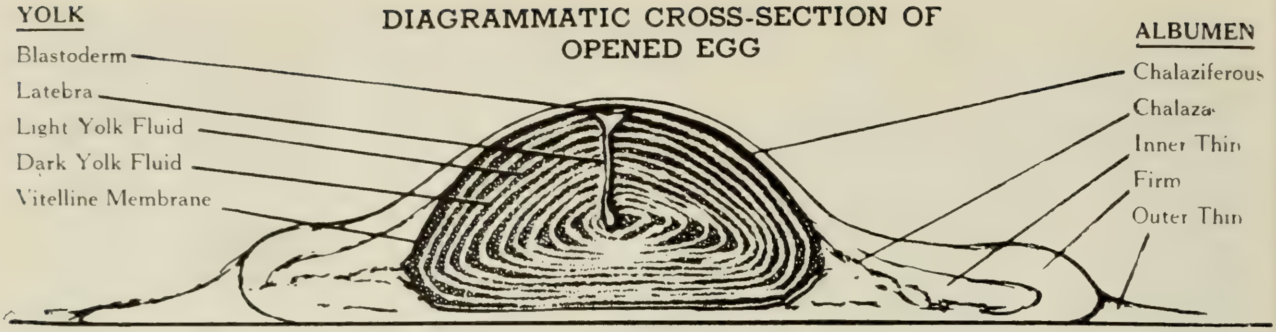


FIG. 10. Note the thin white inside the layer of firm or thick white.

The Egg White—The white of the egg appears to consist of two fractions, thick and thin. Careful examination, however, reveals four fractions, the outer thin and a layer of inner thin, contained within the layer of thick white, but easily released by puncturing this thick white. Also a thin layer of thick white surrounds the yolk and branches out on opposite sides of the yolk to form the twisted cord-like chalazae. These latter help to hold the yolk in a central position within the egg.

The Yolk—The yolk consists of alternate layers of dark and light coloured yolk material surrounded by a containing yolk or vitelline membrane. Yolk size may vary somewhat between breeds and also between individual hens. It also varies with maturity.

The Germ Spot—The germ spot or blastoderm present in every egg, lies on the surface of the yolk just beneath the vitelline membrane, and at the apex of the latebra. (Figs. 8 and 10). This is the point at which, in a fertile egg, the chick embryo commences its development. In a freshly laid or any other good egg the germ spot is inconspicuous, and shows no enlargement or development.

TABLE 8—COMPOSITION OF AN EGG

	The White*	The Yolk*	White and Yolk* Combined	Whole Egg
Water	87.8 %	49.0 %	73.7 %	65.5 %
Protein	10.0 %	16.7 %	13.4 %	11.9 %
Fat	.05 %	31.6 %	10.5 %	9.3 %
Ash	.80 %	1.5 %	1.0 %	.9 %
Carbohydrate	.50 %	......	.30 %	11.2 %(shell)

* R. V. Boucher, Penn. State College.

TABLE 9—THE EGG PARTS

Yolk	32.75 % of total egg	Shell Membrane	.25 % of total egg
White	57.01 % of total egg	Shell	9.99 % of total egg

TABLE 10—SECRETION OF ALBUMEN (EGG WHITE)

Section of Oviduct	Approx. Length in Centimeters	% Albumen Secreted	Approx. Time Spent by Yolk
Mouth	5.0	....	....
Funnel	4.0	....	18 mins.
Magnum	33.0	40-50 %	2 hrs., 54 mins.
Isthmus	10.0	10 %	1 hr., 14 mins.
Uterus	12.0	40-50 %	20 hrs., 40 mins.
Vagina	12.0	....	

Data of Warren and Scott, 1935. Asmundson and Burmester, 1935.

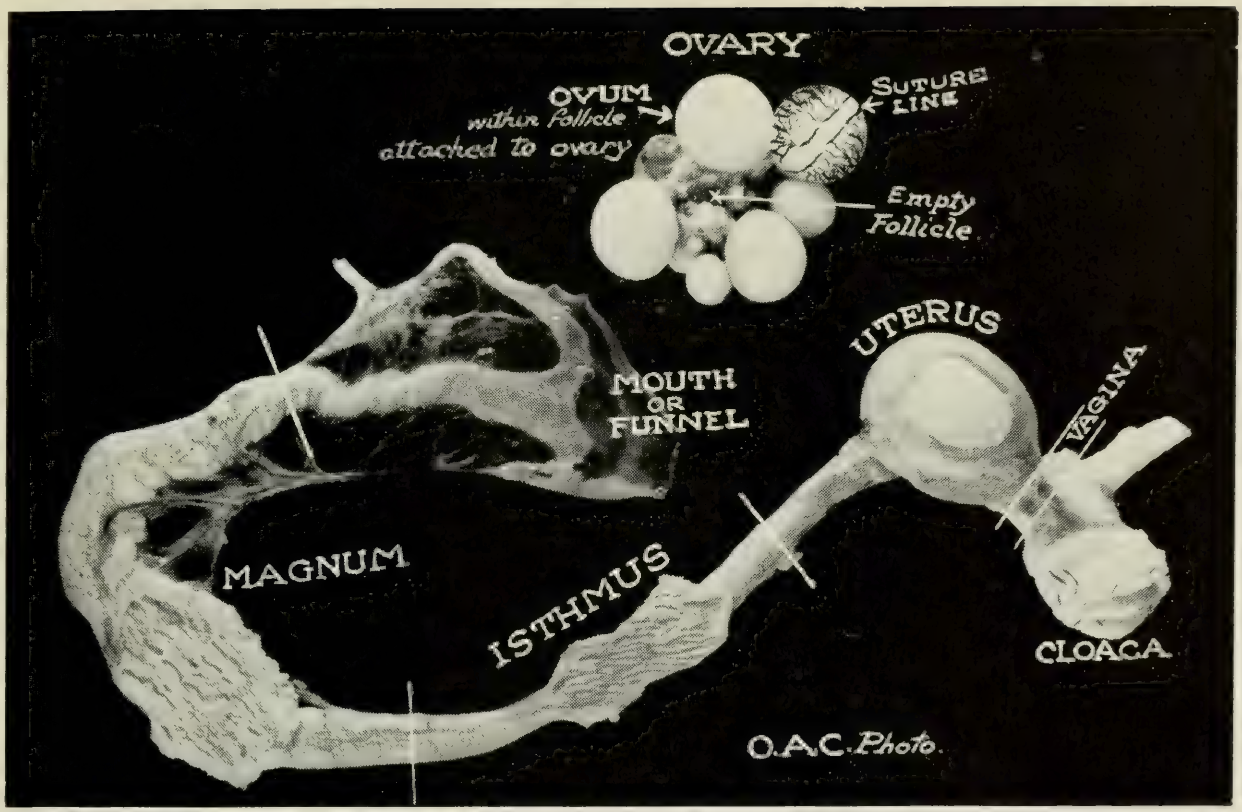


FIG. 11. The mouth or funnel receives the ovum or yolk as it is released from the sac or follicle in the ovary by a rupture of the suture line when the yolk has attained full size. The glands lining the magnum, isthmus and uterus secrete the various parts which, added to the yolk, comprise the complete egg.

PRODUCTION OF AN EGG

The time interval between the ovulation or freeing of the yolk from the ovary to the laying of the completed egg varies from about 23 hours to as much as 30 hours. Table 10 lists the time spent by the yolk and its accruing additions in the various parts of the oviduct. Specialized glandular structures in each section of the oviduct serve to secrete the several parts of the eggs as illustrated. In addition the glands of the isthmus secrete the shell membrane, while those of the posterior part of the uterus secrete the shell. An interesting feature is the secretion of much of the albumen following the formation of the shell membranes. This albumen is absorbed through these membranes by osmotic action and this serves to completely plump the egg prior to the development of the shell.

As illustrated in Fig. 11, the glands of the oviduct are so placed (like the rifling in a gun barrel) as to rotate the "egg" while passing down its length. This rotary movement is a factor in producing the chalazae and in causing the one to be coiled clockwise and the other counter-clockwise.

Both the ovary and oviduct receive a generous blood supply while birds are in laying condition and it is this supply that furnishes the material from which these organs secrete all of the various parts of the egg.

Most eggs are laid small end first.

FACTORS INFLUENCING EGG QUALITY

Quality in eggs is influenced by a number of factors. Some of the more important being: Breeding; Feeding; Seasonal Influences; Management; Physiological Disturbances; Physico-Chemical Changes; Sanitation, Time, Temperature and Humidity.

(1) **Effect of Breeding on Egg Quality and Appearance**—There are at least five inherited characteristics that definitely influence egg quality and appearance, namely, egg size, egg shape, shell colour, shell thickness and texture and interior quality. Because these are inherited, any worth-while or permanent improvement of any or all of these characteristics can only be secured by means of a carefully controlled system of selective breeding.

Such selective breeding may readily be carried on by anyone willing and able to spend the time and effort necessary to do the work. Unfortunately relatively few poultrymen are in a position to do so. Also the great mass of farmers and poultrymen purchase their supply of baby chicks yearly from hatcherymen. Mating the supply flock of these hatcheries with males progeny-tested for known egg quality factors would seem then the most practical means of mass improvement along these lines.

(a) **Egg Size**—Rapid improvement may readily be made in the average egg size of a flock by using breeding males whose sisters and daughters produce eggs of the desired size. The following chart (1) demonstrates the effectiveness of such selective breeding.

Data reported by the Poultry Division of the Central Experimental Farm, Ottawa, indicates a considerable degree of correlation between egg size and bird size within a given variety. Reports from other experimental stations, as well as data of our own gathering, all tend to support this fact. The setting of pullet eggs weighing 24 ounces or more will, over a period of several years, result in improved egg size from the flock. To secure comparable results with hen eggs, only eggs weighing about 25½ ounces or more per dozen should be used. Pullets laying eggs weighing 23 to 23½ ounces per dozen, may as hens lay eggs over 24 ounces per dozen in their second year, though many are inherently breeders of small eggs.

(b) **Egg Shape**—None but normal shaped eggs should be incubated. Eggs too long or too round in shape are difficult to pack commercially without excessive breakage. They are also unattractive in appearance when exposed for sale. While it is difficult to achieve perfection, considerable improvement generally follows careful selection for shape of the eggs set.

(c) **Shell Colour**—Egg shell colour is entirely dependent on the breed. Some breeds such as the Leghorn lay white shelled eggs while others such as the New Hampshire lay brown or tinted eggs, the difference depending on the presence or absence of a pigment-secreting mechanism in the uterus where the shell is secreted. Needless to say, shell colour has no influence whatsoever on interior egg quality, as the shell is the last part of the egg to be formed.

(d) **Shell Texture**—Shell texture is important in the handling of eggs and in regard to eye appeal. While shell texture is influenced by the diet, some birds appear to lack the ability to produce strong, dense shells, even when all known shell-forming ingredients are available in the ration, thus indicating heredity as a factor.

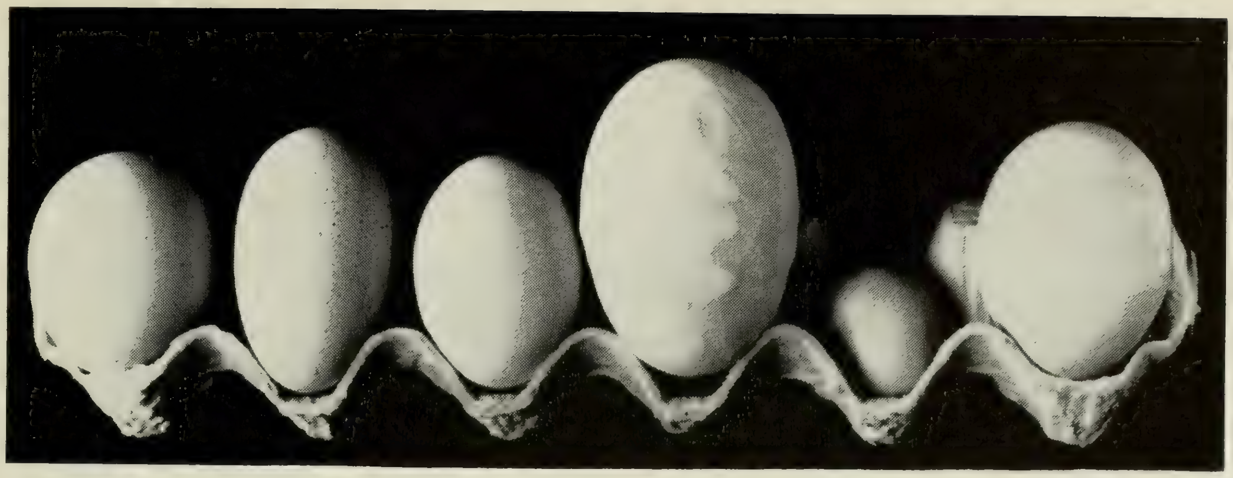


FIG. 12. Eggs of undesirable shape and size lack eye appeal. Compare with Figure 1.

CHART 1—EFFECT ON EGG SIZE, OF BREEDING AND SELECTION IN BARRED PLYMOUTH ROCKS

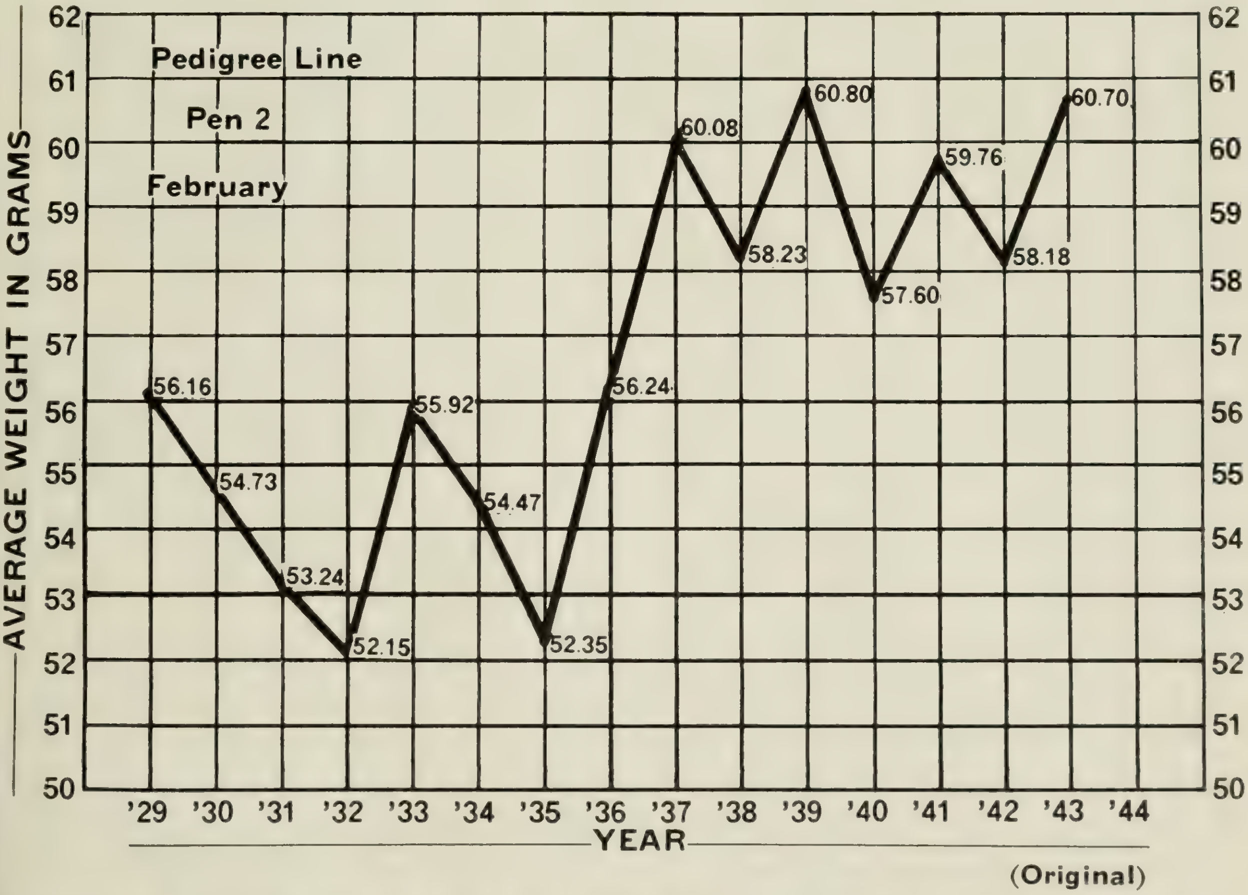


CHART 1. Selection for egg size was initiated in 1935. Some variation in size from year to year is unavoidable. A two-ounce egg weighs 56.7 grams.

(e) **Interior Quality**—The percentage of thick and thin white often varies considerably in the eggs laid by a given flock, even where a finely ground all-mash ration is the only source of feed. Various research workers have found this an individual characteristic of birds very little influenced by feed. It has also been found that eggs having a high percentage of firm white when laid, liquefy less rapidly in storage than those with less thick white. In view of these findings it would seem wise to breed from individual birds, families and flocks that produce eggs containing a large percentage of thick white. Candling eggs prior to hatching is helpful, but the use of pedigreed breeders, especially males whose dams, granddams and sisters exhibit this quality, will produce much more encouraging results.

There are indications that the strength of the vitelline or yolk membranes in eggs is also an inherited characteristic.

Carefully conducted, well organized breeding projects, incorporating all of the foregoing factors should then offer definite possibilities for improving the quality of eggs laid by Ontario flocks. Hatcherymen and breeders alike may be well advised to explore these possibilities.

(2) **Effect of Feeding on Egg Quality**—Feeding affects eggs in several ways. It affects the food value, the quality of the shell, the colour of the yolk and white, the keeping quality in storage and the flavour.

The extensive literature on egg quality contains numerous well-authenticated evidences of the effect of feed on eggs. The amounts of such vitamins as A, B, Riboflavin and D present in eggs are definitely affected by the feed and can be varied to a considerable degree at will, dependent on the amount of these vitamins in the rations. The content of other vitamins, excepting C, is probably also similarly affected.

(a) **Mineral Content**—It has been demonstrated that the addition of cod liver oil to a ration increased the amount of both iron and copper in the egg yolk. The amounts of iodine, silenium, fluorine and other minerals found in eggs have also been increased by feeding.

(b) **Shell Quality**—Apparently at least four feed factors are involved, namely, vitamin D, calcium, phosphorus and manganese[5]. A shortage of vitamin D results in thin shelled eggs and the same is true if insufficient oyster shell or other calcium supply is fed. While there is little phosphorus in egg shells, it is a factor in the balance of minerals and vitamin D necessary for good shell production. One half pound of manganese sulphate per ton of mash where equal amounts of grain and mash are fed, or one quarter pound per ton of total feed fed, is ample.

For best results then, vitamin D, (or direct sunlight), calcium, phosphorus and manganese should be supplied to the layers and in proper balance. The occasional bird which, even on a good diet, habitually lays eggs with poor shells should be slaughtered for food.

(c) **Colour of Yolk**—Yolk colour is an important factor in securing eye appeal of eggs as food. This colour is directly dependent upon the feed consumed by the hen. Carotenoid pigments, such as xanthophyll, zeaxanthin, crytoxanthin and more rarely capsanthin are the pigments involved, the first two being most common. Green feeds such as alfalfa, clovers and grasses, certain weeds such as shepherd's purse and penny cress, yellow corn, carrots and similar materials serve as the source of such pigment in egg yolks. Therefore, control of the amount of pigment carrying feeds in the ration will serve to produce the shade of yolk colour most desired. Limiting access to range will serve the same purpose. Layers should not have access to a wet, boggy barnyard if eggs of superior quality are desired,

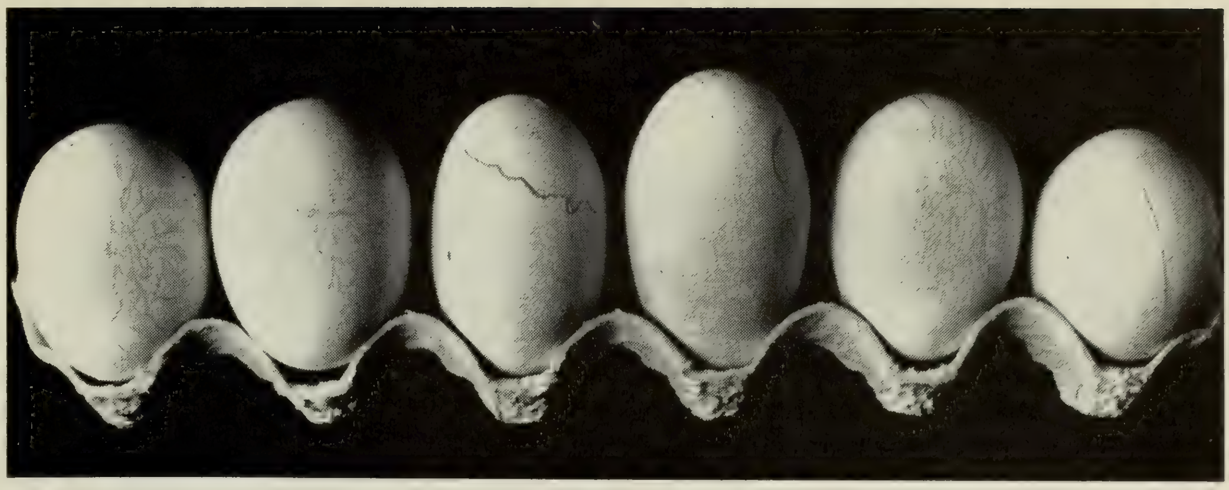


FIG. 13. Such eggs should be used on the farm to avoid breakage and loss during marketing.

as material consumed here may produce undesirable yolk colour and also undesirable flavour. While eggs of superior storage quality are produced in the spring when the flocks are on range, a considerable percentage of them may have yolks too deeply coloured to be included in Grade A. Confinement of the flock during the forenoon and allowing free access to a good laying mash as well as continued feeding of hard grain will largely prevent excessive yolk colour. Depth of yolk colour may or may not be an indication of nutritional value. Cod liver oil may serve as a source of vitamin A without the use of green feed.

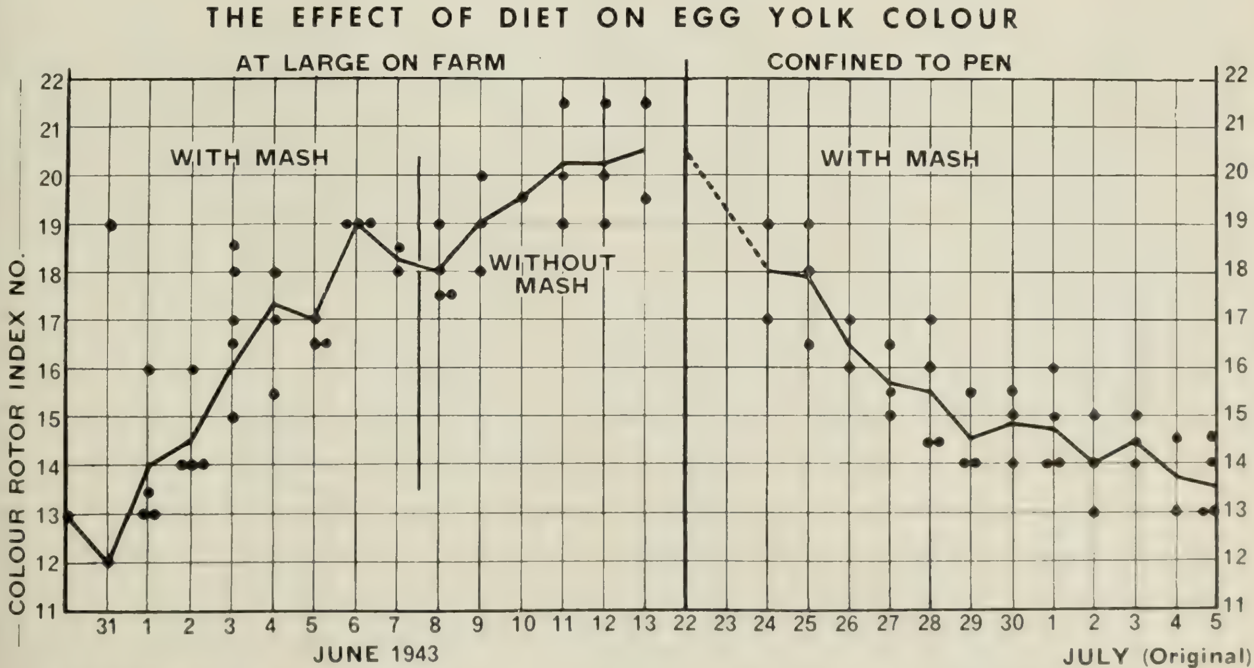


CHART 2. Pullets laying lemon yolked eggs (rotor Nos. 12 to 14) under confined housing and controlled feeding, when moved to a farm and on range (Fig. 18) but fed the same feeds, quickly produced darker yolks, (Fig. 16) (rotor Nos. 19-22), especially when deprived of mash. When again returned to the original quarters and method of feeding, yolk colour returned to the lemon shade.

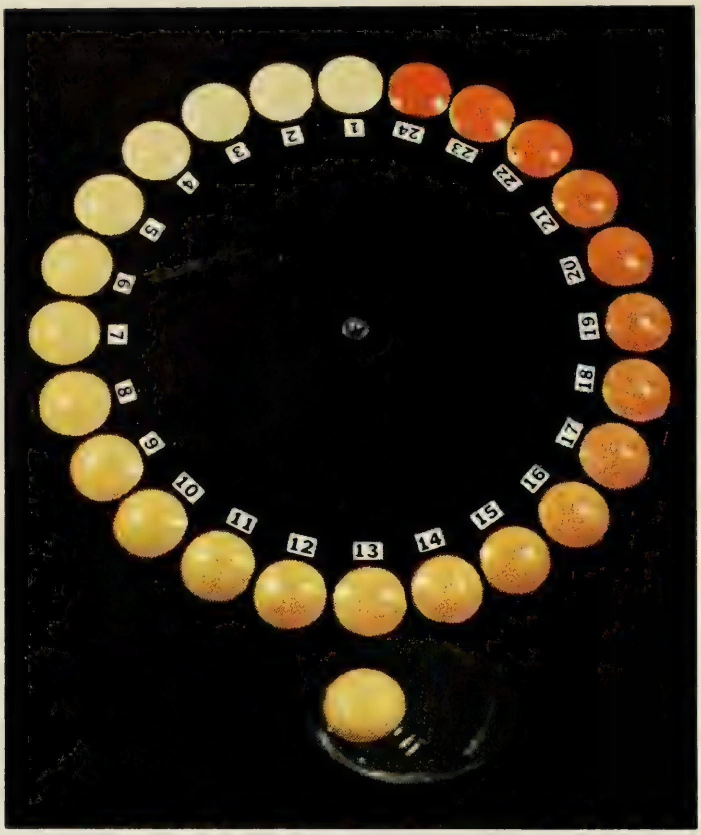


FIG. 14. Colour Rotor — a device used for measuring yolk colour. There are 24 colour gradations ranging from a light cream, No. 1, to a dark orange red, No. 24.

FIG. 15 — LEMON COLOURED YOLKS

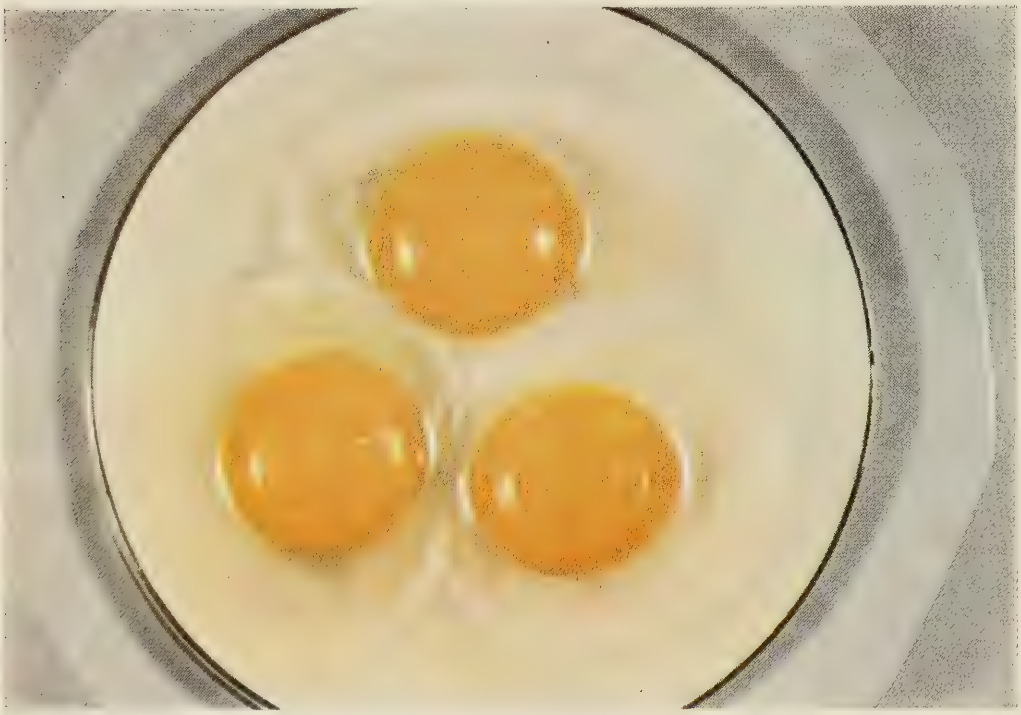


FIG. 15. Confinement and controlled feeding of a balanced ration and a moderate amount of green feed result in moderately light uniformly coloured yolks.

FIG. 16—DARK COLOURED YOLKS

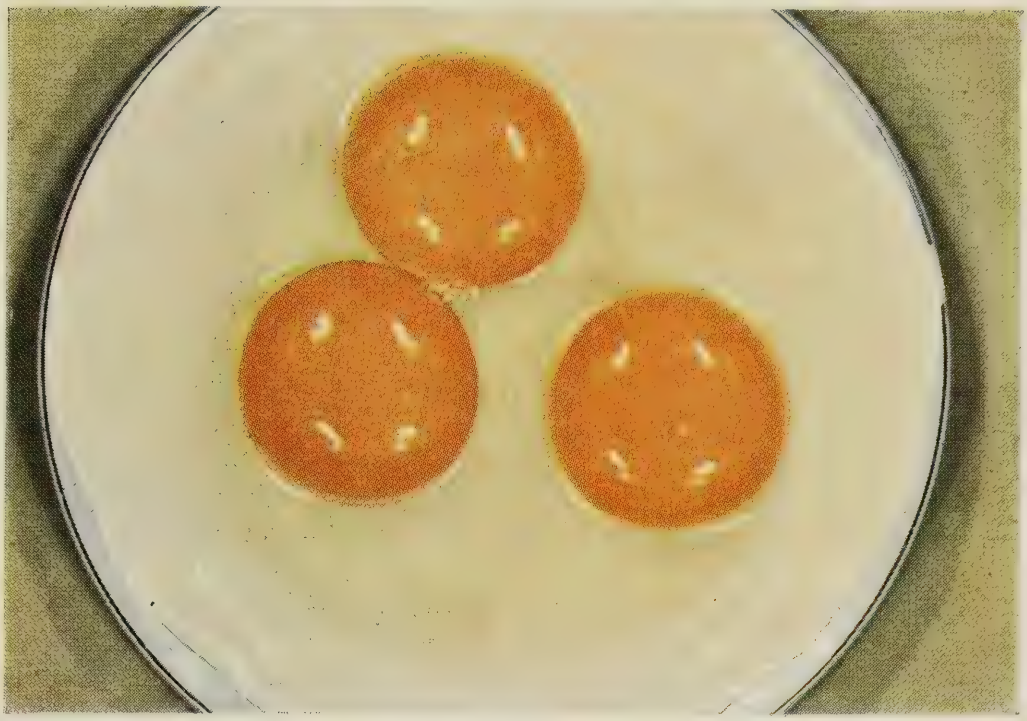


FIG. 16. Excessive green feed or other pigment carrying materials consumed by layers and uncontrolled feeding and management are factors affecting the depth and uniformity of yolk colour.

FIG. 17—MIXED COLOURED YOLKS

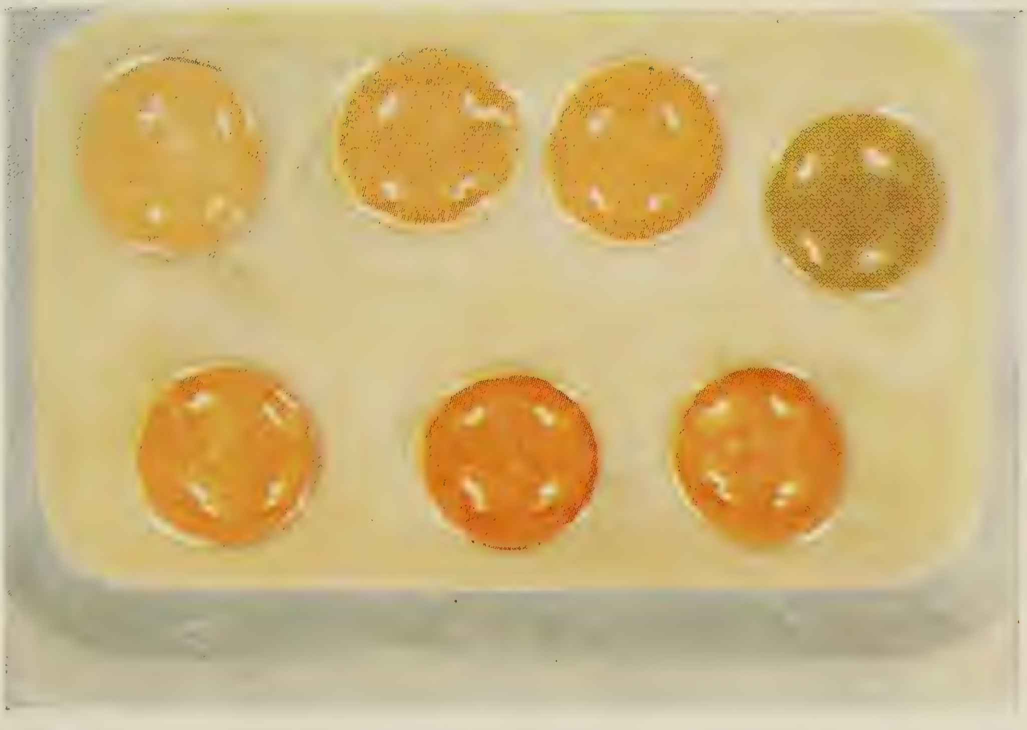


FIG. 17. One day's eggs from a pen of layers under uncontrolled feeding. See Chart 3. A platter of poached eggs having uniform yolk colour has much more "appetite teasing" eye appeal than one varying greatly in this respect.

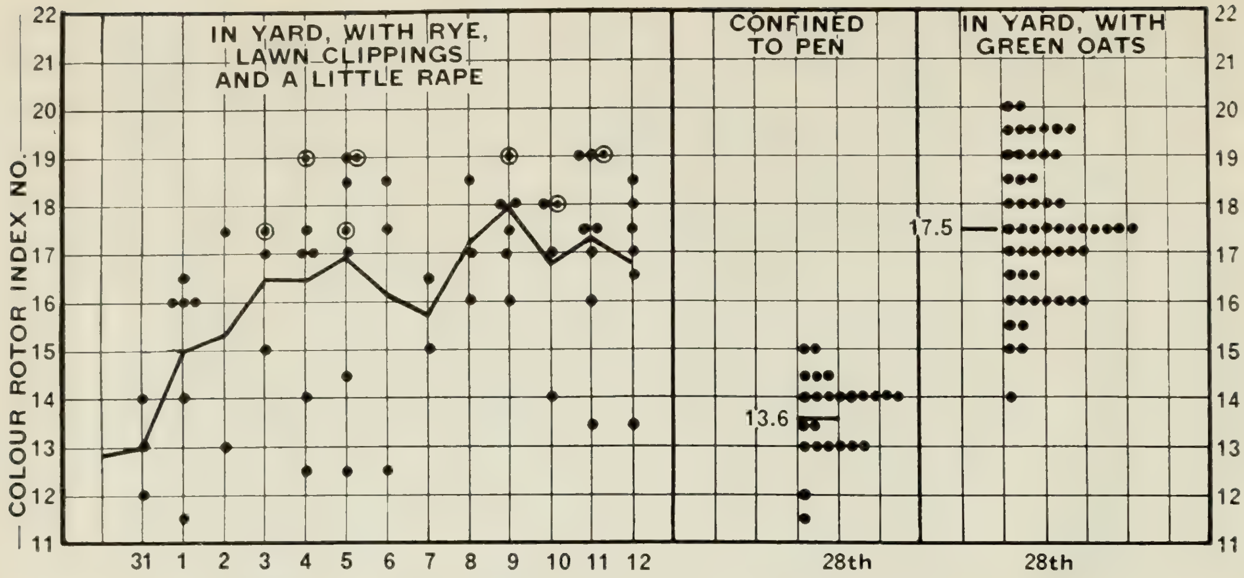


CHART 3. (a) Pullets laying uniform lemon yolked eggs, when allowed outside in a yard seeded to rye and a few rape plants laid eggs with a wide variation in yolk colour (rotor Nos. 12 to 19) and also within four days laid olive green yolked eggs. (Dots with circles). (b) Comparison by scatter diagrams of the yolk colour of eggs laid on July 28th by two pens on the same feed but different management.

(d) **Colour of Egg White**—A comparatively new but interesting development is the recognition that Riboflavin (vitamin G) is indicated in the whites of eggs by a yellow-green colouration. The depth of this colour in eggs varies considerably and is a fair indication of the amount of the vitamin present. It is also now recognized that the depth of colour varies with the Riboflavin content of the ration, irrespective of the source, whether natural or synthetic. It is known that the Riboflavin content of eggs varies rather widely. Within certain limits this condition is controllable. The feeding of adequate levels of such common Riboflavin carriers as milk by-products, livermeal, alfalfa meal and young grasses, results in the production of eggs of high Riboflavin content.

(e) **Keeping Quality in Storage**—Under normal peace-time conditions a considerable percentage of our Spring months' egg production must be stored. Eggs produced from well-balanced rations, which are then quickly cooled and properly stored, largely retain their original quality even after six to nine months in storage. Certain feeding materials may, however, considerably lower the keeping quality. Among such are cottonseed meal, mallow and the feeding of much green feed with an unbalanced ration.[6] Pink, brown and green storage discolouration, particularly of the yolks, often follows access to such material, the extent of discolouration being largely dependent on the amounts fed. If cottonseed is fed at all the amount included in the total ration should be small. Cottonseed contains gossypol and this causes the yolk discolouration.

(f) **Flavour** — The flavour of eggs may be influenced by feeding. Flavour and odour are closely associated and are usually more evident after cooking than before. Such feedstuffs as onions, rape, turnips and some fish meals and fish liver oils have all been reported to produce off-flavoured eggs, when fed in excessive amounts. Excessive consumption of grass-hoppers and other insects may have a similar effect. The best flavour results from the feeding of sweet and clean grains and their by-products, supplemented with high-quality animal and vegetable proteins. To these may be added moderate amounts of green feed.

(g) **Water Consumption** — Water consumption influences egg size; lack of adequate supply resulting in decreased size and also in lowered production. A continuous supply of clean fresh water, cool in summer and slightly warmed in winter, encourages maximum consumption.

(h) **Scavengers** — Inducing the layers to become scavengers by withholding laying mash during spring and summer often results in the consumption of excessive amounts of green feed and other material. Such practice may quite easily adversely affect the colour and flavour of the eggs produced, particularly if the hens are kept under unsanitary yard and range conditions. Such management results in lowered quality of many Ontario eggs and is, therefore, wasteful and uneconomical.

(3) Effect of Seasonal Influences on Egg Quality — The appearance of eggs is greatly influenced by the weather as found in the different seasons of the year. Many more eggs become soiled during the wet spring and fall weather than during the summer and winter. One investigator found 9.8 per cent of soiled eggs produced in July as compared with 24.6 per cent in March.[7] During wet weather yards become muddy and litter becomes wet and soiled. This results in dirty feet. Soiled eggs are the natural consequence when the birds enter the nests to lay.

During those seasons when birds are outdoors and green feed is plentiful, more of this feed as well as other possibly undesirable material is consumed than when confined. While the resultant eggs producd may be of high hatchability, the palatability and broken-out appearance is often less desirable than that found in eggs produced in confinement.

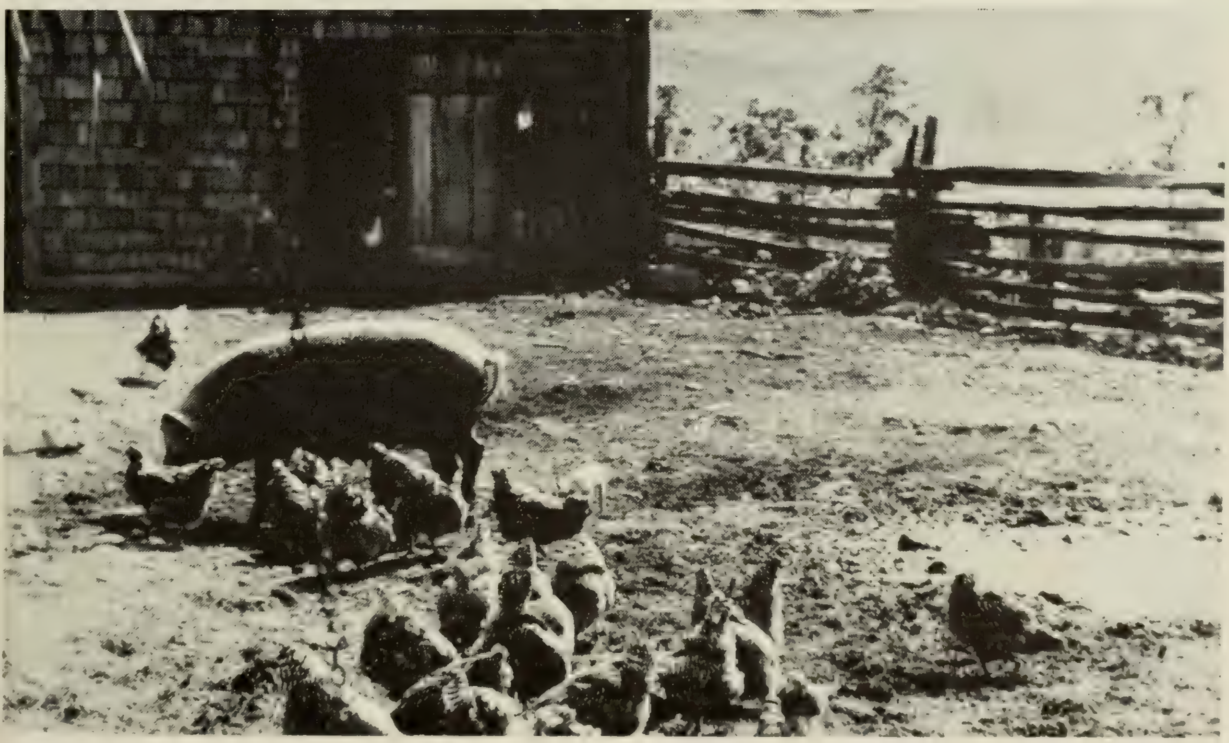


FIG. 18. Eggs produced under such conditions are not of the finest quality or flavour.

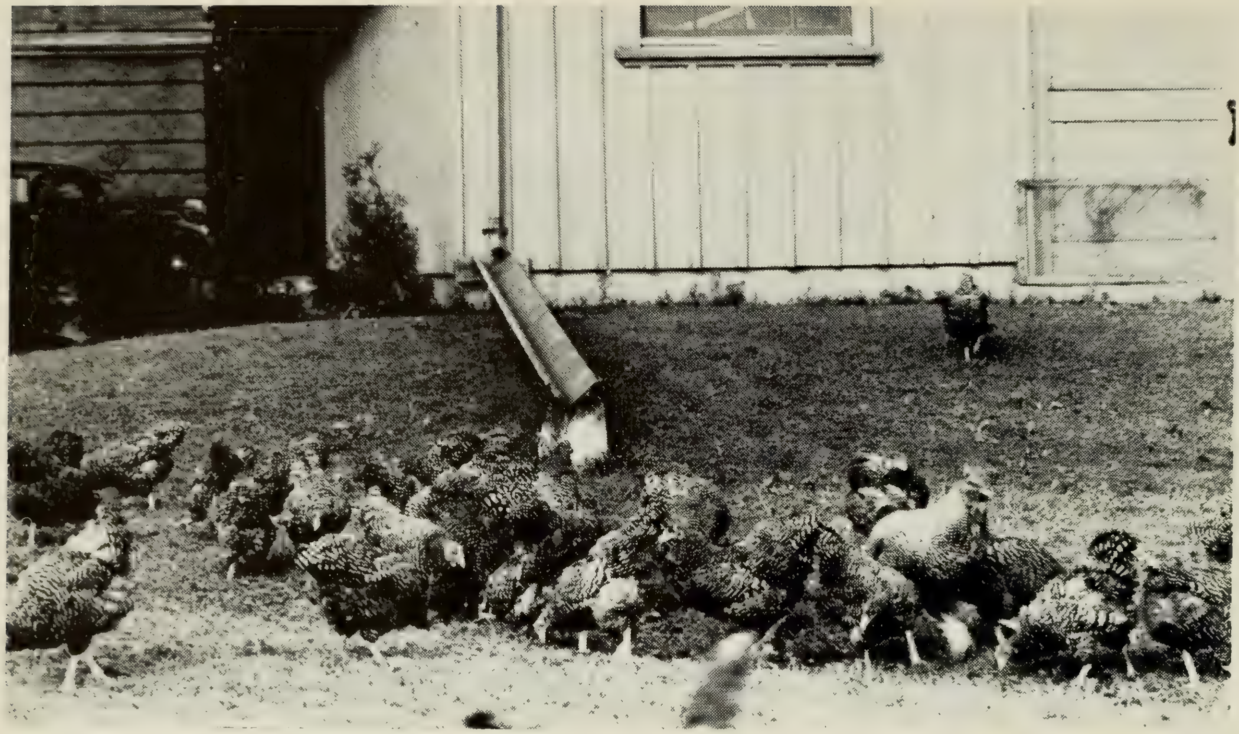


FIG. 19. Eggs from hens receiving plenty of mash and grain and a moderate amount of clean, short pasture are usually of excellent quality.

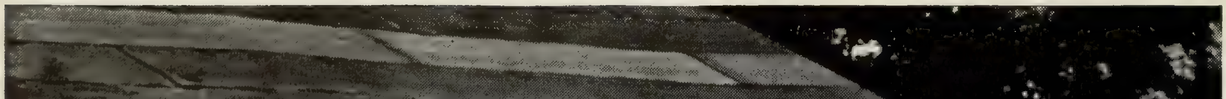


FIG. 20. One means of keeping layers from manure and other refuse.

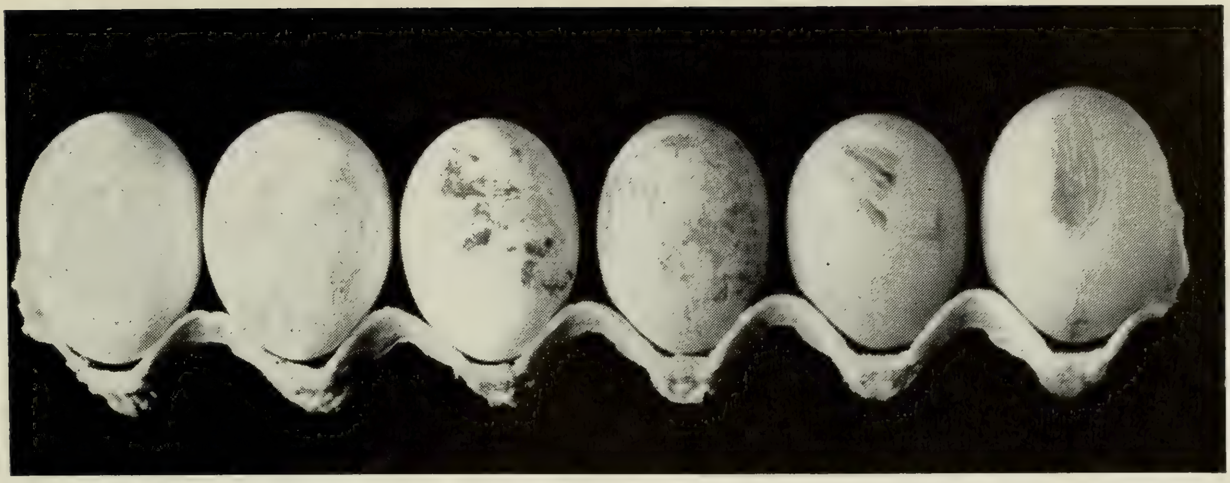


FIG. 21. Slightly soiled eggs are Grade B, and heavily soiled, Grade C (two in centre). Compare with Figure 1.

Cleaning Eggs — There seems to be no way of entirely eliminating soiled eggs. Brown shelled eggs do not show slight soiling as readily as do chalk white ones, but it is there nevertheless. Even after taking the greatest practical precautions we have not been able to reduce soiled shells below from five to six per cent. Soiled eggs are unattractive and produce sales resistance on the part of the buyer. This can only be overcome by lowering the price. This consumer reaction is relative and is overcome by grading slightly soiled eggs B and badly soiled ones C grade, the producer absorbing the loss.

Every effort should be made to produce clean eggs. The loss from soiled eggs can, however, be partly prevented by cleaning. This can be fairly satisfactorily done in several ways. A clean moist cloth will remove slight stains easily. The use of a little acid such as vinegar, or alkaline material such as washing soda, will help dissolve and remove dirt. Steel wool may also be used, or a buffer made out of a sheepskin shoe polisher over which is fastened a strip of emery cloth. Such abrasives tend, however, to produce shiny spots on the shell.

Machines for cleaning eggs have been developed and produce satisfactory results. They are of two main types, one using whirling loops of emery cloth and the other blasts of sand. Due to their high cost, such machines are economical only on very large poultry farms or at collection points where large numbers of eggs are handled.

Badly soiled eggs should be washed. Such eggs, if stored, do not, however, keep well, chiefly due to the rubbing of filth and bacteria into the pores during washing. Where quantities of eggs are to be washed, either for storing or before breaking for drying or freezing, keeping quality is greatly increased by washing in a solution of Sodium Hydroxide (common lye).[8] One-half to one per cent. of lye is sufficient and the strength must be kept uniform. This may be done by the use of a hydrometer. Rubber gloves are necessary to protect the hands, and the eyes and clothing must also be given protection as lye is very corrosive. Eggs washed in lye solution have been reported to keep as well in storage as clean, unwashed eggs.

A number of investigators have reported a tendency toward a lowering of egg quality as indicated by broken out appearance, with the advent of summer weather. The best quality is reported to occur about February. This difference is reported to be independent of temperature.

Egg shells often tend to decrease in thickness and quality during April and May, and egg size also decreases somewhat at the same time. Usually the largest eggs and the best shell quality are found in late January and February. There is then a gradual downward tendency until late July and August, after which there is again improvement in these respects. The date of hatching and the age of bird may be influencing factors. It appears, however, that less blood calcium is present in the birds' blood in warm weather, resulting in a lower rate of calcium deposition.[9] Cool, comfortable laying houses, secured by good ventilation and insulation are helpful, but it is often difficult to entirely prevent the production of weak-shelled eggs at this season. Sometimes extra vitamin D will help, as the birds spend so much time in the shade, out of the sunlight and heat, that additional vitamin D assists in improving calcium assimilation and deposition.

(4) Effect of Management on Egg Quality — Proper management may assist greatly in the production and retention of the highest quality in eggs. Keeping the flock confined away from unsuitable feed and out of unsuitable yards is important. Continual feeding of a good laying mash and grain while birds are allowed to forage outdoors will largely prevent any ill effect on quality from such forage. Confinement during wet days will prevent many dirty eggs.

Keeping the yards and litter dry and clean and screening the dropping boards and pits prevents many dirty eggs. Supplying sufficient suitably placed, clean and well-bedded nests is another important factor, while removal to other quarters of all broody hens and frequent gathering of eggs prevents quality loss and much breakage. Birds should not be allowed to remain in nests overnight.

The feeding of over-laxative feed results in soiled bedding and soiled eggs. Poor drinking vessels also contribute by the wet litter which develops around them. Many eggs become soiled by being handled with dirty or wet hands and by being gathered and stored in dirty utensils.

Eggs should be gathered frequently and cooled quickly. Recent investigations show that measurable albumen quality loss occurs in eggs left in a nest on a hot day, even for so short a time as four hours.[8a] This loss is increased where the egg is sat upon and kept warm by a hen.

Rough handling on the farm and in transit may result in breakage or if less severe, in injury to the air cell and other internal egg structure and so hasten lowered quality. Such damage is increased where eggs are not packed large end upwards. The use of soiled flats and fillers is a factor in the production of musty eggs and rots, especially if the eggs are stored or held in an over-damp, poorly ventilated place. Strong, clean fillers in the egg crates support the eggs better and prevent breakage, some types being superior to others in this respect. Over-large eggs may cause excessive breakage and also the soiling of surrounding eggs. As stated elsewhere, eggs are very susceptible to the absorption of odours and flavours. Storage near tar, coal oil, fish, onions or even oranges may easily result in the absorption of such flavours. For this reason eggs should not be stored in refrigerator rooms where oranges or other fruits have been stored unless the rooms are first deodorized.

Need for proper management is not confined to the producer alone. Due to the great perishability of this product, all persons connected with the industry must practise equal care. Quick cooling, proper storage, correct packing and rapid transfer under optimum conditions from producer to consumer are all equally important in securing maximum results for all concerned.

(5) Effect of Physiological Disturbances on Egg Quality—

(a) **Abnormal Eggs and Rejects** — Notwithstanding the variety of conditions under which they are produced, the great majority of newly laid eggs are of excellent quality and attractive as food. There is, however, a small and varying percentage of eggs that are, due to the occurrence of certain abnormal physiological reactions during their development, more or less objectionable. A better understanding of these is helpful to both producer and consumer.

(b) **Blood Spots** — Occasionally eggs are laid containing varying amounts of blood. Such eggs, because of their objectionable appearance, are classed as rejects when graded. Losses from this source range from about one-half to ten per cent or more.

The immediate cause is considered to be a rupture of or leakage from small blood vessels on the follicle or sac in which the yolk or ovum develops in the ovary. Many of these hemorrhages occur between the follicle and the yolk membrane (intra-follicularly). The amount of blood released may be minute or relatively large. Recent research indicates these hemorrhages mostly occur before the yolk is freed from its follicle.[10] It is possible that some occur when the follicle ruptures along its suture line to release the yolk at the time of ovulation. It is also possible that hens with hemorrhagic ovaries from any cause will produce abnormally high percentages of eggs with blood spots.

Possible Causes:

(1) **Heredity** — Some families are much more subject to the production of blood spots than are others, even under identical feed, care and management. This strongly suggests heredity as a factor.

(2) **Over-Stimulation of the Reproductive System** — There are often more blood spots during peak production. Most trouble is experienced in the spring months, some in the fall, less at other times.

(3) **Excessive or Violent Exertion** — This may be brought about by fright, jumping from high perches and similar conditions. It is assumed that the excessive muscle tension reaches all parts of the body including the follicle around developing yolks, and may cause abnormal rupture of suture lines during ovulation. Some recent investigations cast doubt on this theory.[10] The exact cause of blood spots is still in question. Further research is needed as authorities and investigators are still somewhat in disagreement.

(c) **Bloody Eggs** — In such cases the amount of blood is relatively large and is often diffused throughout the white.

Cause — Similar to blood spots, though there is a possibility that some such leakages may occur in the upper part of the oviduct (magnum) where about 40% to 50% of the egg white is secreted.

(d) **Meat Spots** — Recent investigations indicate most meat spots as blood spots in various stages of degeneration due to changes in the blood through oxidation and other factors.[10] The blood colour changes from red to brownish, gradually fading until practically colourless. High temperatures and increased pH (hydrogen ion concentration) have been suggested as contributing causes of this change in colour. Some meat spots may consist of sloughed off ovarian tissue and even small ova. Several of the latter have been observed by the author.

At times these blood and meat spots become a real problem. In a recent investigation by the author a total of 652 eggs laid by 12 pens of Barred Plymouth Rocks were broken out daily as laid over a period of four days. Of this number 17 eggs or 2.6 per cent contained blood spots and 369 or 56.6 per cent contained meat spots, making a total of 59.2 per cent. Only a small number of these were observed by candling as fortunately many of the spots were no larger than specks of pepper.

Only eggs with very large meat spots are classed as rejects. All others discernable by candling are classed C grade. This is because their appearance is less objectionable than that of blood spots and they can be readily removed when the eggs are broken out for use as food.

(e) **Other Abnormalities — Double or Multiple Yolked Eggs** — About 40 per cent. of double yolked eggs result from the ripening and ovulation of two yolks at the same time. These move down the oviduct together and are enclosed in a common shell. The remainder have been reported as mainly due to the failure of the oviduct to "pick up" an ovum until the stimulation created by the ovulation of a second ovum occurs. When commencing to lay, over-stimulated pullets sometimes lay triple or even quadruple yolked eggs.

Eggs containing abnormally large and very cloudy yolks occasionally occur. Others have the white rather jelly-like in appearance or resembling mucous, while still others contain coagulated fibrin. A temporary catarrhal condition or inflammation of the oviduct may be a factor in the production of the latter. Such eggs occur infrequently and are easily candled out. Very small eggs sometimes occur containing a small amount of yolk, a meat spot or a small mass of thick white instead of a normal yolk as their centre. These also are of no value.

Eggs with rough or corrugated shells and others with flattened areas, the latter often checked with poorly repaired cracks, are other abnormalities. (Fig. 13). Over-fatness, with masses of fat pressing against the uterus and heredity are causes, and rough handling of the birds may also be a factor.

(6) Effect of Sanitation, Time, Temperature and Humidity on Egg Quality.

(a) **Broken Out Appearance** — Most eggs from flocks under controlled feeding and sound management are high in quality no matter what the basis of judgment. The average consumer reaction depends chiefly on the egg's broken out appearance, which in turn is directly correlated with the appearance when prepared for food, as when soft boiled, poached, fried, hard boiled or whipped. An egg that "stands up" well when broken out, looks attractive and palatable both before and after cooking. In Figures 22, 23, 24 and 25, a series of four eggs is shown that illustrate maximum, high, medium and low quality when judged by broken-out appearance. Critical examination involving the yolk index, the albumen index and careful measurements of thick and thin white makes possible relatively exact measurements of such quality. These yolk and albumen indices are determined by dividing the measured height of each by its mean diameter, the measurements being taken with finely graduated and exact instruments.

A study made at the O.A.C. Poultry Department in 1941, of 1,807 eggs, revealed 1,307 (72.3%) with the appearance shown in Figure 22; 353 (19.5%) like Figure 23, and 128 (7.1%) like Figure 24 or intermediate between Figures 23 and 24. In addition 19 eggs (1.04%) were like Figure 25 except that the majority of the yolks were not quite as flat. The eggs in question were laid by four breeds and were broken out and examined immediately after thorough cooling. The broken out quality varied somewhat with the breed and even more with individual birds within the breed. Other investigators report somewhat similar results.

Not only do eggs vary in quality when laid, but those from individual hens may vary considerably in keeping quality when stored.

In addition to these differences, eggs will change rapidly in broken out appearance from that of Figure 22 to that of Figure 25, dependent upon certain physical and chemical changes, the extent and speed of these changes being in turn dependent upon the factors of sanitation, time, temperature and humidity.

Eggs are never better than when first laid. The longer they are stored, the less desirable in broken-out appearance do they become. High temperatures greatly hasten deterioration. The writer has frequently reduced Grade A eggs to B and even to C grade in one week by storing at room temperature (70°-85° F.). Eggs so held will also show an enlarged germ spot and, if fertile, may even undergo sufficient embryonic development to show blood vessels. Ten days to two weeks of hot weather invariably result in greatly lowered quality of the eggs reaching the market, and, largely because of this, also in a considerably reduced consumer demand. This lowering of quality can and should be prevented as decreased demand results in lowered price to the producer.

(7) Physical and Chemical Reactions That Lower Egg Quality — High-grade eggs contain a high percentage of firm or thick white. The proportions of fluid and firm white in eggs varies considerably and this variation appears to be chiefly due to hereditary factors rather than to the diet. The outer fluid white has been reported to comprise 20 to 55%, the firm white 27 to 56%, and the inner fluid white 11 to 36% of the total egg white.[3] A number of reactions take place in eggs during the interval between laying and consumption. Some of these are physical, some chemical and others a combination of the two. As a result of these reactions the air space increases in size due to loss of moisture through evaporation and the weight of the egg decreases; the white tends to thin and decreases in amount and becomes increasingly alkaline. The yolk increases in size, the yolk membrane becomes weakened and easily ruptured and the yolk flattens when broken out.

When freshly laid the egg contains approximately .5% of carbon dioxide, (CO_2). The thick white at this time appears rather cloudy or opaque, particularly if cold, but soon becomes clear. Holding results in a gradual loss of CO_2 and with it a loss of the original "fresh" flavour. This is quite apparent in an egg stored for several months. The loss of CO_2 also affects the hydrogen ion concentration or pH of the egg, resulting in increased alkalinity; the freshly laid egg having a pH of about 7.6 while that of a held egg may rise to 9.5 or higher. This represents an increase in alkalinity of about 80 times.

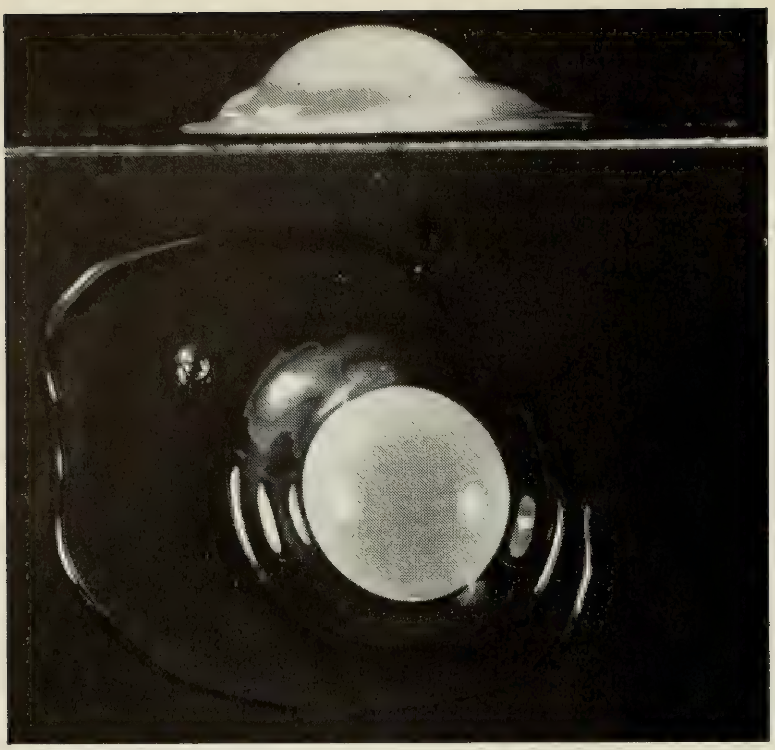


FIG. 22. A "streamliner"; in other words, a top quality egg. Note the height and curve of the yolk and the small diameter of the thick white. There is little thin white and the yolk is located directly in the centre of the thick white. This condition is only found in very high quality eggs.

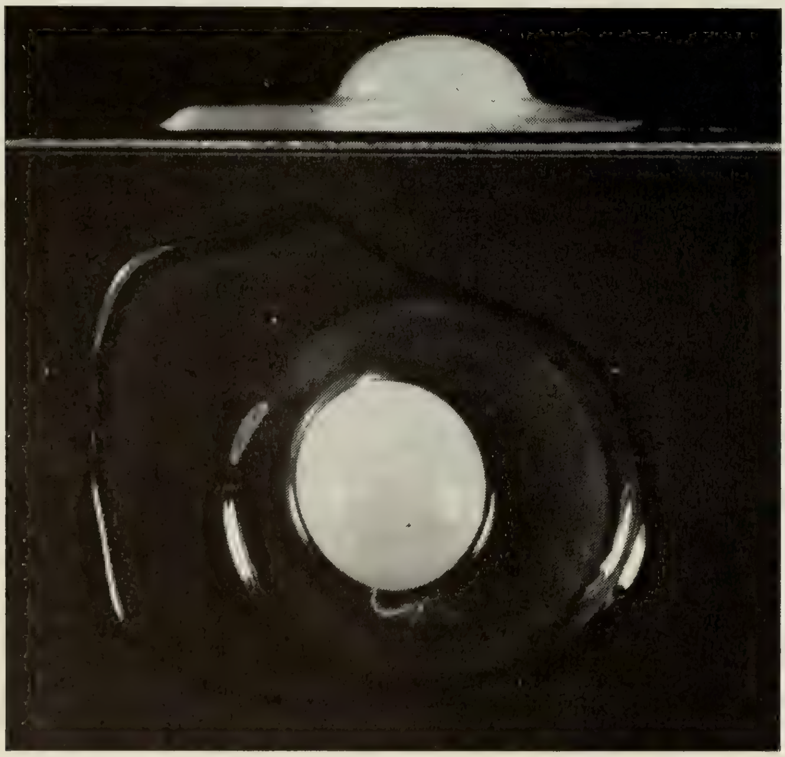


FIG. 23. A good egg. This egg is an A Grade egg and good enough to satisfy most people. Notice, however, that the yolk is lower in height and that the thick white is lower in height and greater in diameter than is the case in the streamliner, indicating some thinning out. Notice particularly that the yolk has moved somewhat to the side of the thick white and is not so well centred as in the streamliner. One or two days of storage in a moderate temperature will produce this result.

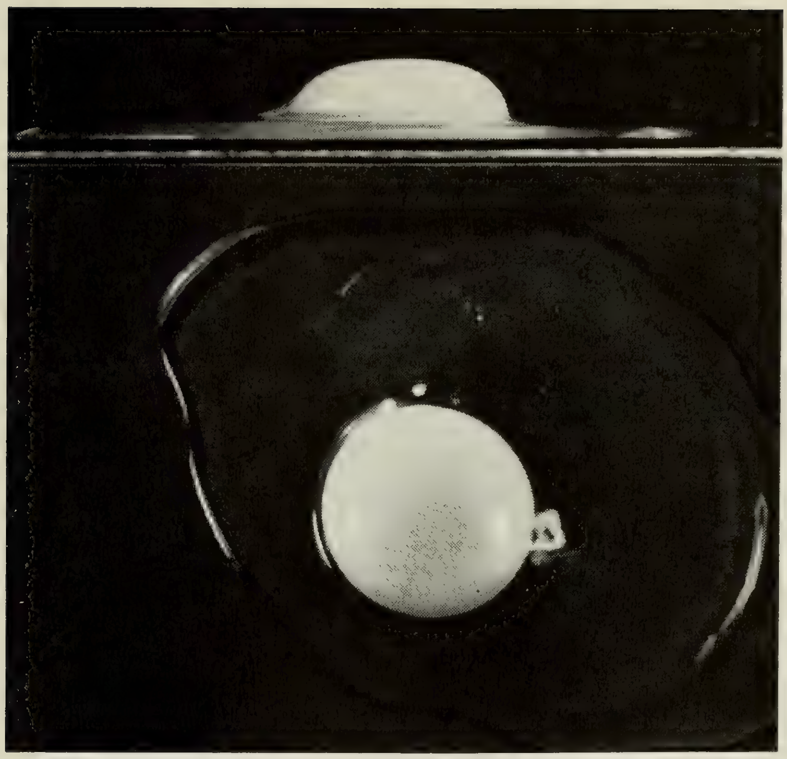


FIG. 24. A satisfactory egg but showing the effect of holding under unsatisfactory conditions or for too long a time. It would grade B Grade. The yolk has flattened and has definitely lost height. The thick white has become weak and has lost so much height that the diameter has greatly increased. The yolk is now well off to one side, but is still of good quality. Holding an egg for even one week under ordinary summer storage conditions will lower the quality of some eggs to B Grade.

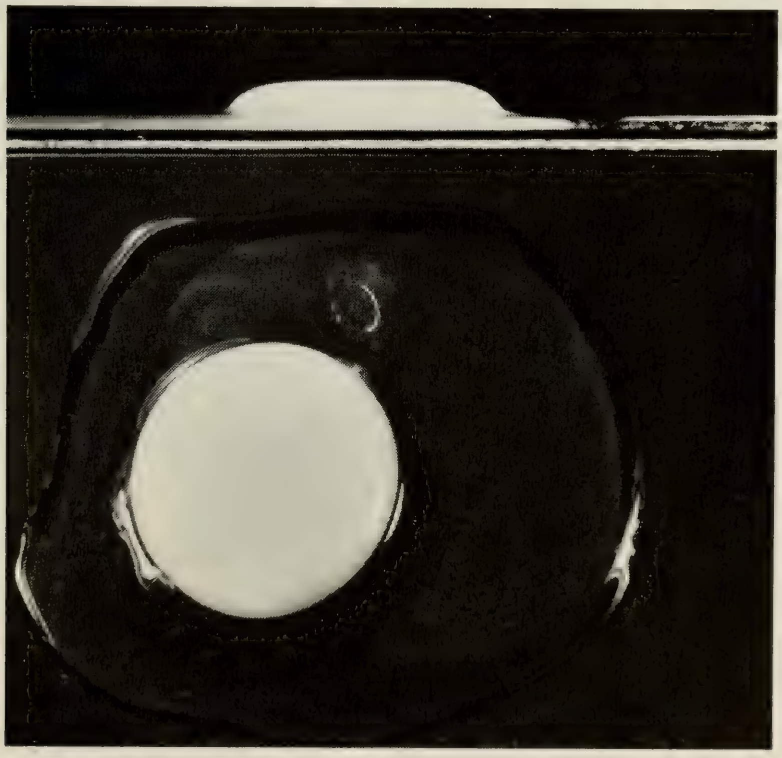


FIG. 25. An egg that was once fresh. It would still grade C Grade but is not a very good C. The yolk is badly flattened and so much enlarged that it is easily ruptured. It has moved well off to one side so that little more than half is surrounded by thick white. The thick white has almost the diameter and area of the thin white and is difficult to distinguish from the thin white. Ten days to two weeks of low humidity and rather warm temperatures, 70 to 80 degrees F., produce this result, whereas immediate cooling and proper temperatures, 50 to 65 degrees F., along with a humidity of 75 per cent, would have kept this egg in A Grade condition for an even longer period of time.

BROKEN OUT APPEARANCE OF EGGS OF CANADIAN GRADES

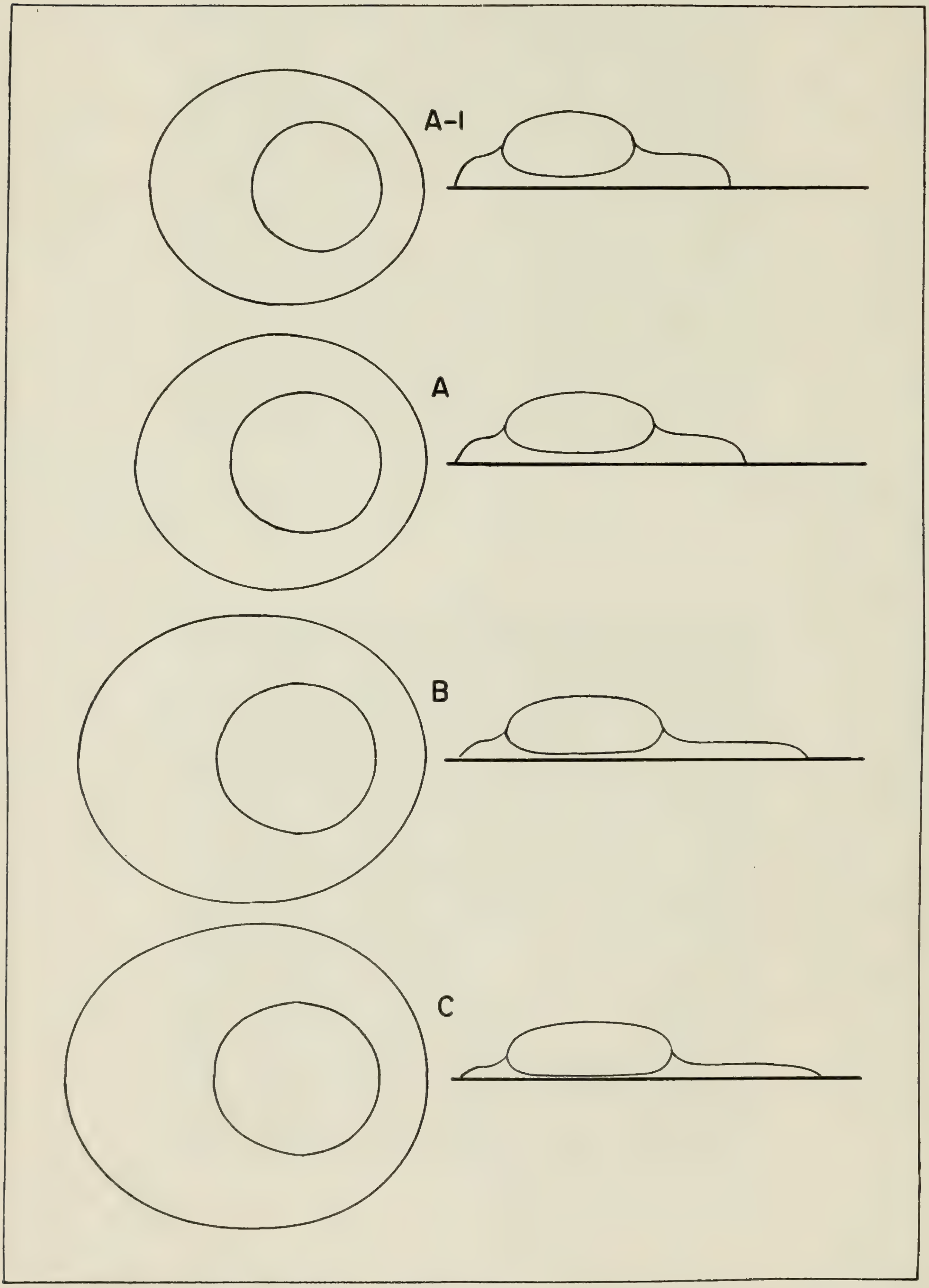


FIG. 26. Drawn from average measurements of a group of eggs of each grade as candled by a member of the Federal Inspection Service.

The difference between firm and fluid white is considered to be chiefly due to a difference in mucin fibre content, firm white having about nine times the mucin fibres present in fluid white.[3] Loss of CO_2, with its attendant increase in alkalinity, tends to cause a breakdown of the mucin fibres and as a result thinning of the firm white. This whole reaction is greatly accelerated by high temperatures, but retarded by low temperatures.

There are also normally present in eggs, certain enzymes.[3] These are organic catalysers which under certain conditions of temperature and hydrogen ion level tend to stimulate the biochemical changes which result in the thinning of egg white.

Furthermore, the absorption of water by the yolk through the yolk membrane, from the rapidly thinning white of improperly held or stored eggs, results in increased yolk volume. This is due in part at least to osmotic reaction taking place through the semi-permeable yolk membrane and results from the variation in concentration between the yolk material and the thinning white. Because of this reaction, the yolk membrane becomes stretched and weakened and the yolk flattens. It finally tends to rupture when the pH rises to or exceeds 9.5.

TABLE 11 — THE EFFECT OF AGE OF EGG ON THE PROPORTIONS OF YOLK AND WHITE

	Whole Eggs			Edible Portion of Eggs*		
	White	**Yolk**	**Shell**	**Loss**	**White**	**Yolk**
	%	%	%	%	%	%
2-day old	57.27	30.84	11.38	0.51	65.00	35.00
Commercial	56.50	32.04	10.94	.52	63.81	36.19
Storage	52.53	35.17	11.39	.91	59.90	40.10

(U.S.D.A. Agr. Marketing Service) * Total weight less weight of white, yolk and shell.

Note the increased weight of yolks and the corresponding decreased weight of whites in the older commercial and storage eggs.

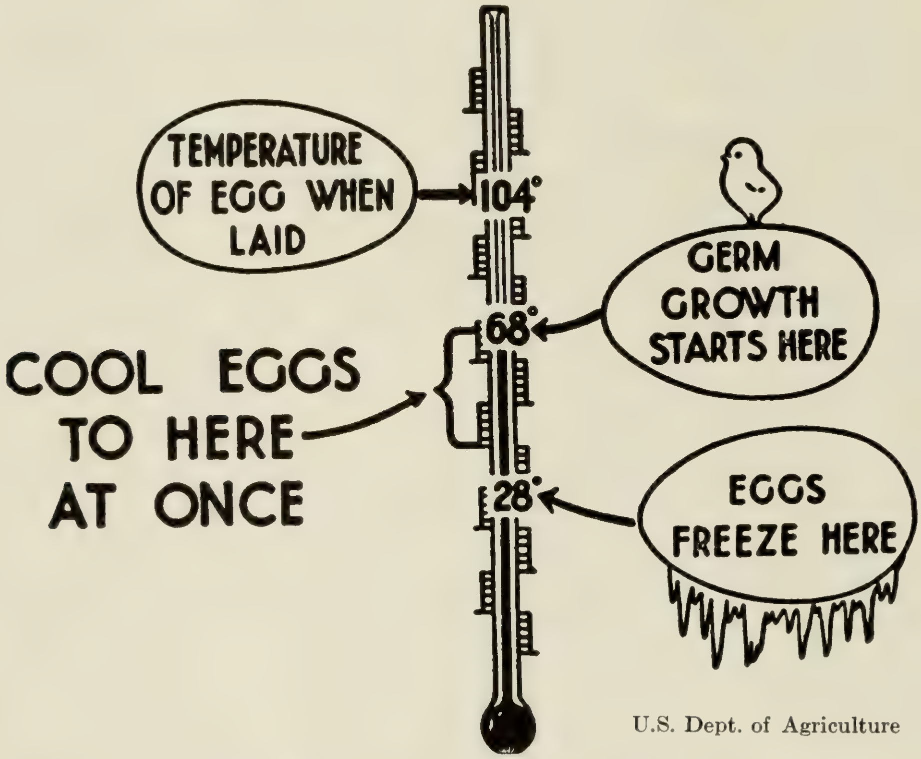
Rapid and continued cooling assists greatly in slowing down most of the reactions described. If cooled to from 50° to 65° F. directly after being laid, eggs will, if so held, keep in Grade A condition for from one to two weeks or even longer. They would retain their original quality even better at 35° to 40° F. but will sweat when later exposed for sale at ordinary room temperatures. Sweating encourages mould growth and results in musty flavours and spoilage unless necessary precautions are taken to prevent this. This may be done by removing the eggs from low into higher temperatures gradually and into air with low relative humidity. Low temperature is essential because it retards bacterial growth and also retards rapid thinning of egg white. Furthermore, as embryonic development commences in fertile eggs at 68° F., temperatures below that point serve to prevent such development.

TABLE 12 — TIME NECESSARY FOR FERTILE, FRESHLY LAID EGGS TO DETERIORATE, AT STATED TEMPERATURES, TO THE QUALITY OF U.S. STANDARD. (APPROXIMATELY GRADE B.)

Temperatures	**Time in Days**
98.6°F.	3
77.0°F.	8
60.8°F.	23
44.6°F.	65
37.6°F.	100

Sharp and Powell, Cornell University.

Much of the deterioration taking place in fresh, stored and processed eggs results from the growth of bacteria and moulds. These organisms multiply rapidly once they gain entrance because eggs are a favourable media for their growth. While most clean eggs are practically free of bacteria, soiled eggs are heavily contaminated. Washing with tap water improves the appearance but tends to open the pores and affords greater ease of entrance. Shell membranes, albumen and yolks may quickly become infected and in spite of the germicidal effect of egg white (due to the presence of lysozyme) on many of these micro-organisms, deterioration of quality and economic loss follow. Microbial multiplication occurs only in water solution and most rapidly under fairly high temperatures. One cannot over-emphasize the need for sanitation in handling eggs nor can one over-emphasize the need for rapid cooling, as low temperatures greatly retard the growth of both bacteria and moulds. It has been repeatedly shown experimentally that eggs properly cared for rarely show contamination.


TEMPERATURE OF EGG WHEN LAID
104°
GERM GROWTH STARTS HERE
68°
COOL EGGS TO HERE AT ONCE
28°
EGGS FREEZE HERE

U.S. Dept. of Agriculture

FIG. 27. Thermometer showing correct holding temperatures.

TABLE 13 — RATE OF COOLING AS AFFECTED BY THE CONTAINERS USED

Hours	Single Egg	Wire Tray	Wire Basket	Galvanized Pail	Chilled Case	Warm Case
0	101.0° F.	102.0° F.	100.0° F.	98.5° F.	97.2° F.	92.0° F.
1	61.1	86.9	96.0	97.9	96.2	91.8
2	51.3	74.4	87.2	95.9	94.5	91.3
3	......	66.5	79.1	92.2	92.0	90.2
4	......	61.0	72.7	87.0	89.8	88.6
5	......	56.5	67.5	82.1	87.5	86.1
10	......	......	56.5	65.6	76.5	75.5

At an egg room temperature of 50° a single egg can be cooled below germ development temperature (69°) in one hour; eggs on a wire tray, 3 hours; eggs in a wire basket, 5 hours; eggs in a galvanized iron pail, 10 hours; eggs in a chilled case, 18 hours; and eggs in a warm case, 20 hours.

E. M. Funk, U. of Missouri.

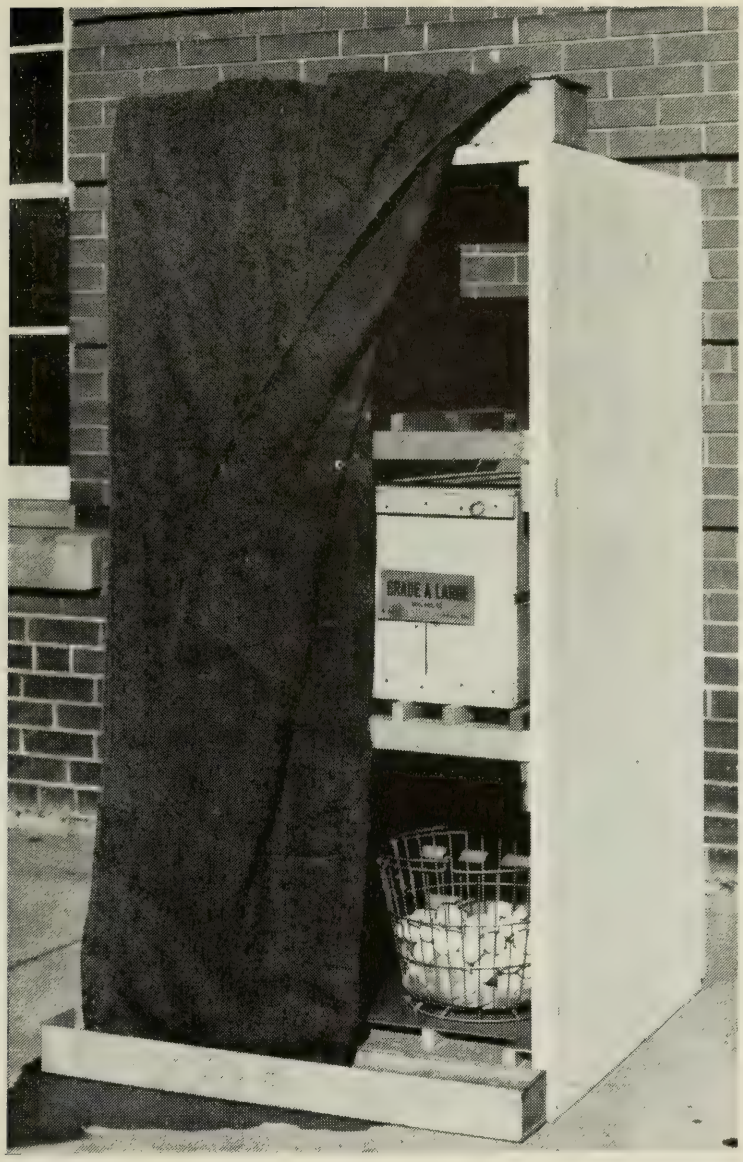


FIG. 28. **Where summer storage room facilities are inadequate, this simple egg cooler will further lower the temperature and increase the humidity by evaporation of water from the jute curtain covering the front.**

High humidity in the storage room retards evaporation and so slows down increase in air cell size in eggs. As the air cell size is a factor in grading, it pays the producer to hold eggs until marketed, in a room with a relative humidity of from 70 to perhaps 80%. The same is true for eggs held by the dealer and also the housewife. In cold storage warehouses eggs are frequently held at from 88 to 92% humidity, but care is necessary to create sufficient air movement to prevent mould development, otherwise likely at these high humidity levels. Eggs held at 29 to 31 degrees F. in a properly humidified storage room will keep in good condition for from 6 to 9 months.

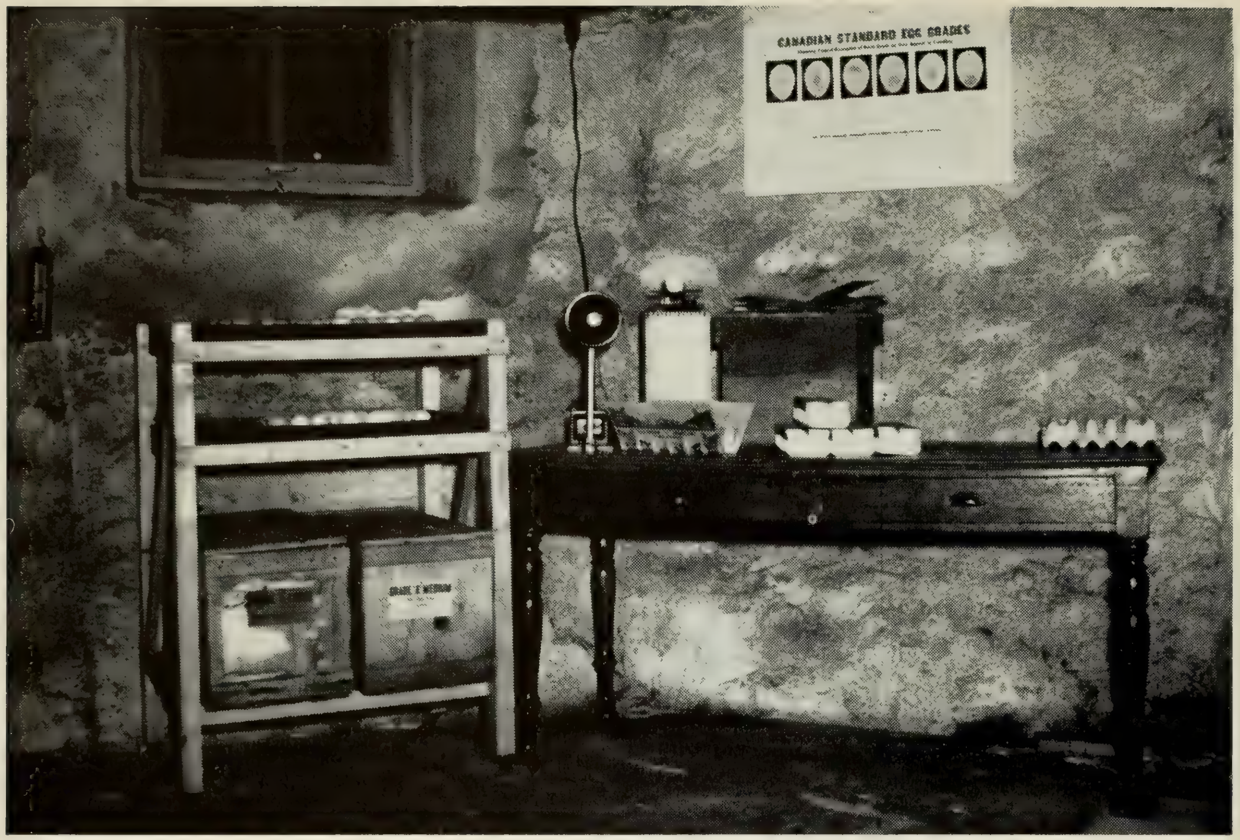


FIG. 29. Inexpensive and satisfactory equipment for properly cooling, grading and packing eggs on the farm.

The Farm Egg Cooling Room—Frequent gathering and rapid cooling of eggs on the farm are imperative for quality retention during hot weather. The north-east corner of a cool, clean basement is an excellent location for the egg room. For best results this space should be partitioned off with insulating board and fitted with wire-bottomed cooling trays, a table and necessary crates, fillers and other equipment. A good egg candle is also needed if grading is to be done on the farm. A lamp with a green filter, a good reflector and a strong, well-centred light is best. For ventilation the room should have an easily opened window, screened against flies and protected from sunlight and summer heat by shrubbery. A shade or curtain will exclude light while candling. Humidity may be increased when desirable by putting water on the cement floor, but care must be taken to prevent the development of moulds which may be done by the addition of a little formalin to the water.

A good storage room in which eggs may be held with a minimum of loss until marketed is one of the prime essentials for improving market egg quality. Holding eggs under unsuitable conditions results in lowered quality and reduced returns in lowered quality and reduced returns to the producer. On large commercial farms a specially constructed, well insulated room is a necessity. This may be kept cool by means of a small, thermostatically controlled refrigerating and humidifying unit. Attention to these points along with regular and frequent marketing in clean containers will assure the producer top grades and prices for his product.

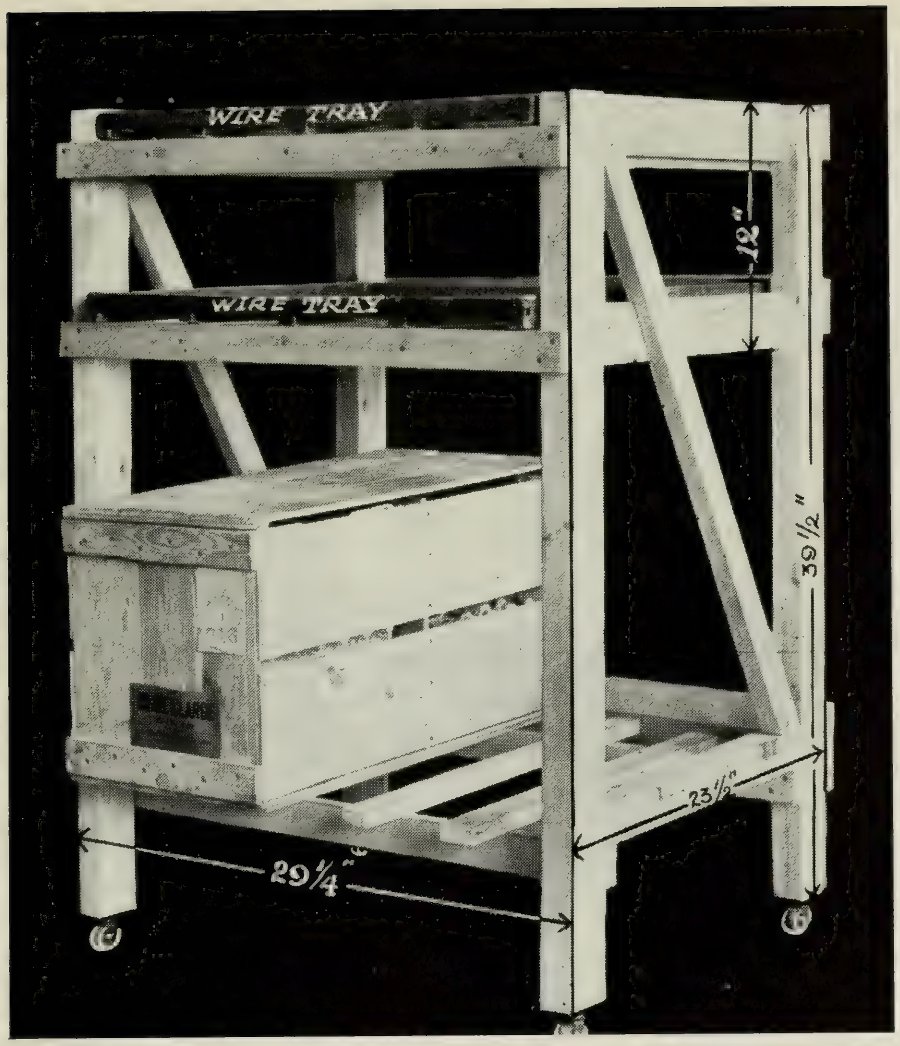


FIG. 30. A simple stand to hold one or more wire-bottomed trays and a shelf off the floor for egg cases.

OILING EGGS FOR RETENTION OF QUALITY

Oil treating eggs with a light, tasteless and colourless oil tends to close the pores and so retards CO_2 loss and reduces evaporation. This also slows down physical and chemical changes within the egg and so helps retain the original quality longer than when not treated. Certain mechanical and economic difficulties have served to limit the use of oil in the past, but these are largely being overcome. Three methods have been employed, namely, dipping, spraying and the vacuum-carbon dioxide method. The latter, developed by the Food Research Division of the U.S. Bureau of Agriculture, Chemistry and Engineering, has given excellent results though the dipping and spray methods are better known and more extensively used. All these methods, because of equipment needed, are only practical at central collection points. The proper physical constants (specific gravity, viscosity and pour point) are more important than the quantity of oil applied. Recent experiments at the Michigan Agricultural Experiment Station indicate the possibility of adding an antibiotic or germ-killing agent to a suitable oil and applying such an oil to eggs on the farm immediately after being cooled, and within 24 hours after being laid.[11] In this way bacteria and mould spores on the shell are destroyed and the original egg quality largely retained, more so than at present when oil dipping, if done at all, is done after the eggs reach the wholesaler, by which time considerable quality deterioration may have already taken place.

KEEPING THAT GOOD EGG GOOD

As has already been suggested, judged by any reasonable standards, healthy, well-bred, well-fed and properly managed hens will, with relatively few exceptions, lay high-quality eggs. The few exceptional eggs can, for the most part, be readily candled out and discarded. What is important is that the quality put into the egg by the hen be retained until the egg is consumed. To do this requires maximum efficiency on the part of all engaged in the industry, commencing with the producer and ending with the housewife or chef. A chain is only as strong as its weakest link. Carelessness on the part of either the farmer, grading station operator, first receiver, transporting agency, wholesaler, or retailer, will result in lowered egg quality and decreased consumer satisfaction and demand. To most successfully bridge the gap between the nest and skillet requires the utmost in gentle, speedy handling and the maximum in control of temperature, humidity and sanitation.

The eye and appetite-teasing appeal and consequently the maximum use in Canadian and other consumer diets of this health-producing food, depends largely upon the recognition of these facts followed by suitable and definite action on the part of all concerned.

Following is stated in tabulated form, control measures of the factors recognized as affecting production and retention of egg quality:

1. Produce infertile eggs except during the breeding season. Cockbirds make good soup and pot-pie, but do not increase production nor improve summer egg quality. At summer temperatures (85° to 95° F.) a fertile egg will germinate sufficiently that the embryo will be visible to an alert candler in as little as 72 hours.

2. Keep a well-balanced laying mash available at all times even if the layers are allowed free range.

3. Feed grain such as wheat and oats or barley daily. Depriving the layers of mash and grain forces them to become scavengers. Excessive consumption of greenstuffs, insects and waste, results in highly-coloured yolks and may also produce marked and undesirable flavours. Such eggs are not attractive or palatable to the consumer.

4. Prevent dirty eggs by providing one clean, well-bedded nest for every four or five birds and by providing clean pens, clean or screened off dropping boards or pits and clean, dry yards.

5. Confine the flock until noon on wet days and fence layers out of wet and dirty barnyards.

6. Confine broody hens and if possible close the nests at night to prevent roosting therein with resultant fouled bedding.

7. Gather eggs frequently, at least three times per day. This helps prevent quality loss by frost in winter and sustained high temperatures in summer. It also prevents accumulation of eggs in the nests and subsequent breakage.

8. Handle eggs carefully and with clean, dry hands and in clean utensils. Cracked and soiled eggs result in great loss to the producer and also to the whole industry.

9. Cool eggs quickly by storing immediately after gathering in a clean, cool and moderately humid room or basement. Storage room temperature of from 50° to 65° F. with a relative humidity of from 65 to 80 per cent is practical and will usually satisfactorily conserve quality. Most rapid cooling is secured by spreading on a wire-bottomed tray as illustrated (Fig. 30). This also aids in the location of soiled, cracked and abnormal eggs. Wire baskets and moulded egg trays, though less efficient, may also be used for this purpose and afford more rapid cooling than do pails or fruit baskets. Where room temperature and humidity are borderline, a home-made cooler may pay well for time and labour, (Fig. 28) and where sufficient volume of eggs is produced, a commercial cooling and humidifying unit may be a necessity.

10. Pack in clean cases, flats and fillers to prevent soiling and mould development. Moulded packing material, such as Keyes trays or cup flats, is efficient in avoiding breakage and loss. It also facilitates rapid handling.

11. Pack eggs with large ends uppermost as this tends to keep the yolks well centred. Eggs left lying for days on their sides tend to show darker yolk shadows when candled because the yolks rise nearer the surface.

12. Handle eggs gently and carefully at all times to prevent injury to the interior structure. Rough handling may cause tremulous air cells and may even rupture weak yolk membranes.

13. Have your eggs graded at a registered grading station or grade them yourself at the farm. Badly stained, poor shelled and cracked eggs are best used at home. Eggs often deteriorate considerably, especially during hot weather, if handled through a first receiver rather than through a registered grading station, as many first receivers lack facilities for proper holding and also for rapid movement to grading stations. This often results, according to statistics from across Canada, in from 10 to upwards of 25 per cent lower grade eggs, the producer taking the loss.

14. Market eggs regularly, at least twice each week if possible, especially in summer. Eggs never improve with age.

15. Move eggs rapidly through the marketing channels either to the consumer or the cold storage room.

16. Transport to market in a covered conveyance and if possible in the cool of the day or at night. Refrigerated trucks should be used. More care is often taken in the transportation of alcoholic and other beverages than in the handling of our very necessary and highly nutritious eggs.

17. Retail in stores from a refrigerator case similar to butter and other perishable products.

18. Store in the home until used in a cool, fairly humid place, the household refrigerator being excellent for this purpose.

It is a serious nutritional and economic waste to lower egg quality by careless handling.

TABLE 14 — COMPARISON OF GRADES AND RETURNS FROM THIRTY DOZEN EGGS FROM EACH OF SIX FARMS
WEEK OF APRIL 2, 1945

Flock No.	Large	Medium	Pullet	% A Grade	B Grade	% B Grade	C Grade	% C Grade	Cracks	% Cracks	Rejects	% Rejects	Returns	Loss per Case	Average Price Rec'd per Dozen
Perfection	30-0	0-0	0-0	100.0	0-0	0	0-0	0	0-0	0	0-0	0	9.00	0	30.0c
Flock No. 1	28-7	0-5	0-0	96.6	0-2	.55	0-0	0	0-8	2.2	0-2	.55	8.80	.20	29.3c
Flock No. 2	18-6	4-11	0-8	80.3	2-11	9.7	0-6	1.7	2-5	8.1	0-1	.28	8.34	.46	27.8c
Flock No. 3	11-2	4-10	4-8	68.8	6-6	21.7	0-3	.83	2-7	8.6	0-0	0	7.92	.88	26.4c
Flock No. 4	14-5	4-8	0-4	64.4	8-10	29.4	0-2	.55	1-7	5.3	0-0	0	8.27	.53	27.6c
Flock No. 5	0-0	0-0	0-0	0.0	22-6	75.0	6-0	19.87	1-2	3.8	0-4	1.2	6.90	1.90	23.0c
Flock No. 6	1-9	0-1	0-0	6.1	27-6	91.7	0-1	.28	0-5	1.4	0-2	.55	7.50	1.30	25.1c
Paying Price Per Dozen	30c	29c	23c		25c		18c		16c						

NOTE: Flock No. 1—Excellent.
Flock No. 2—Excessive number of cracked and soiled eggs.
Flock No. 3—Excessive number of soiled and cracked eggs.
Flock No. 4—Large number soiled.
Flock No. 5—Preponderance of soiled eggs.
Flock No. 6—Graded down largely because of of dark yolks.

A thorough understanding and the best possible control of the foregoing conditions and factors influencing eggs and egg quality are imperative for maximum success in the production and sale of market eggs. Widespread application of this knowledge will result in a product that will create and retain the confidence of consumers at home and abroad. Furthermore it will put dollars into the pockets of observant and adept producers.

As a practical example, facts gleaned from a visit on April 2nd, 1945, to a typical egg grading station located at the Guelph Creamery, Guelph, may well be cited. From the day's receipts grade slips for thirty dozen eggs from each of six representative producers were selected and studied. The results are tabulated in Table 14 and illustrated in Figure 31. Grade A Large eggs commanded 30 cents per dozen on that date, or $9.00 per case. It is illuminating to compare the high percentage of Grade A eggs received from Flock No. 1 and the subsequent high returns, with the percentage of Grade A eggs and the returns for a similar number of eggs from the other five flocks.

Unseasonable numbers of small eggs in Flock No. 3 indicate faulty breeding and management. Inadequate help is a possible contributing factor in the excessive number of soiled and cracked eggs from Flocks No. 2, 3, 4 and 5. Flock No. 6 was probably turned outdoors, deprived of laying mash and the birds forced to become scavengers. Is it not also possible that most or all of the flock owners were somewhat careless in failing to realize the perishability of their product and its dependence for quality on proper feeding and management? In any event it cost them money. It also lowered the quantity of top quality eggs obtainable for market and export.

It is a serious nutritional and economic waste to lower egg quality through a lack of knowledge of requirements and through careless handling.

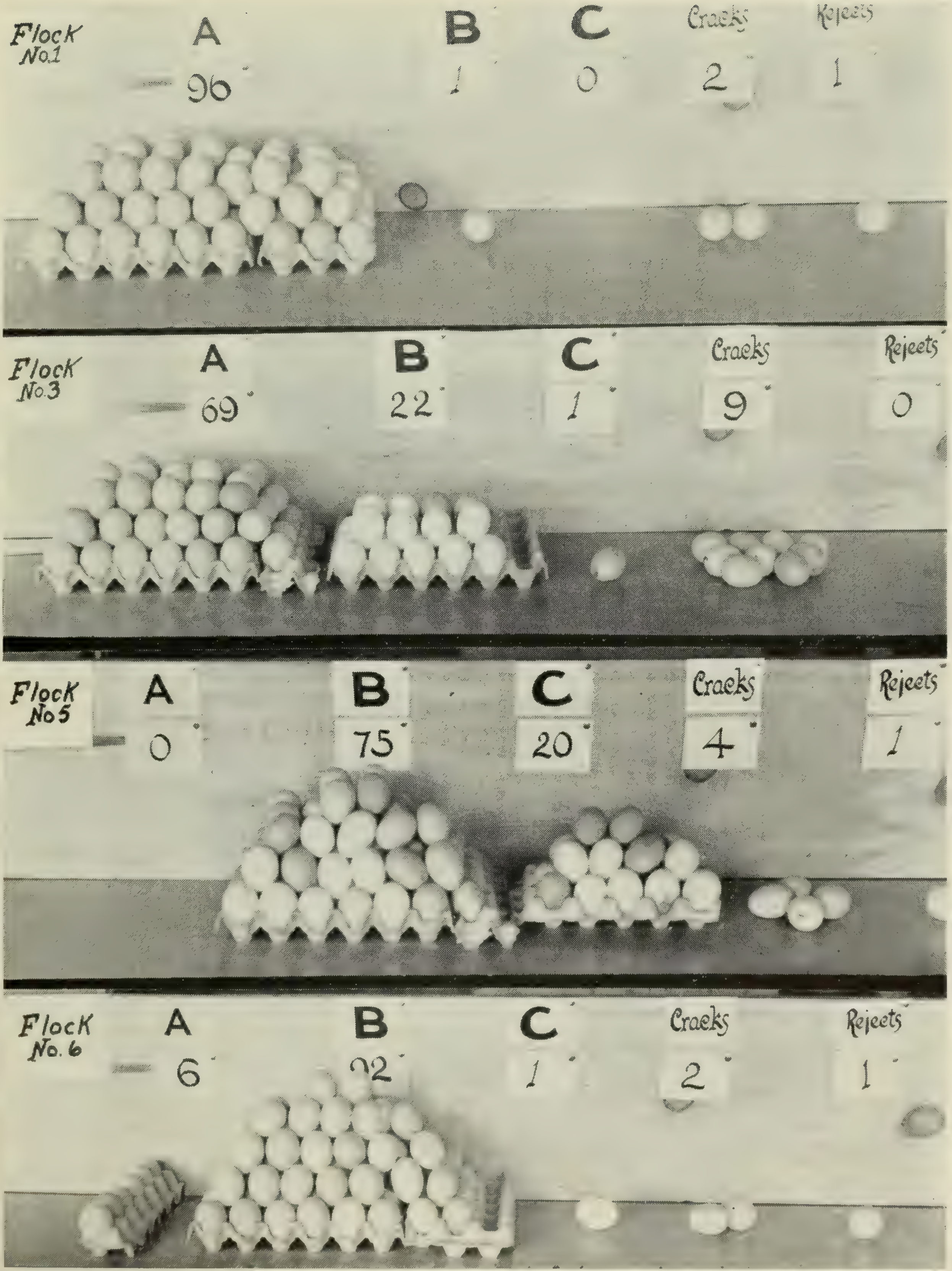


FIG. 31. Photographic representation of the number of eggs of each grade in the cases of eggs brought to the grading station on April 2nd, 1945, from each of flocks 1, 3, 5 and 6. (See table 14.)

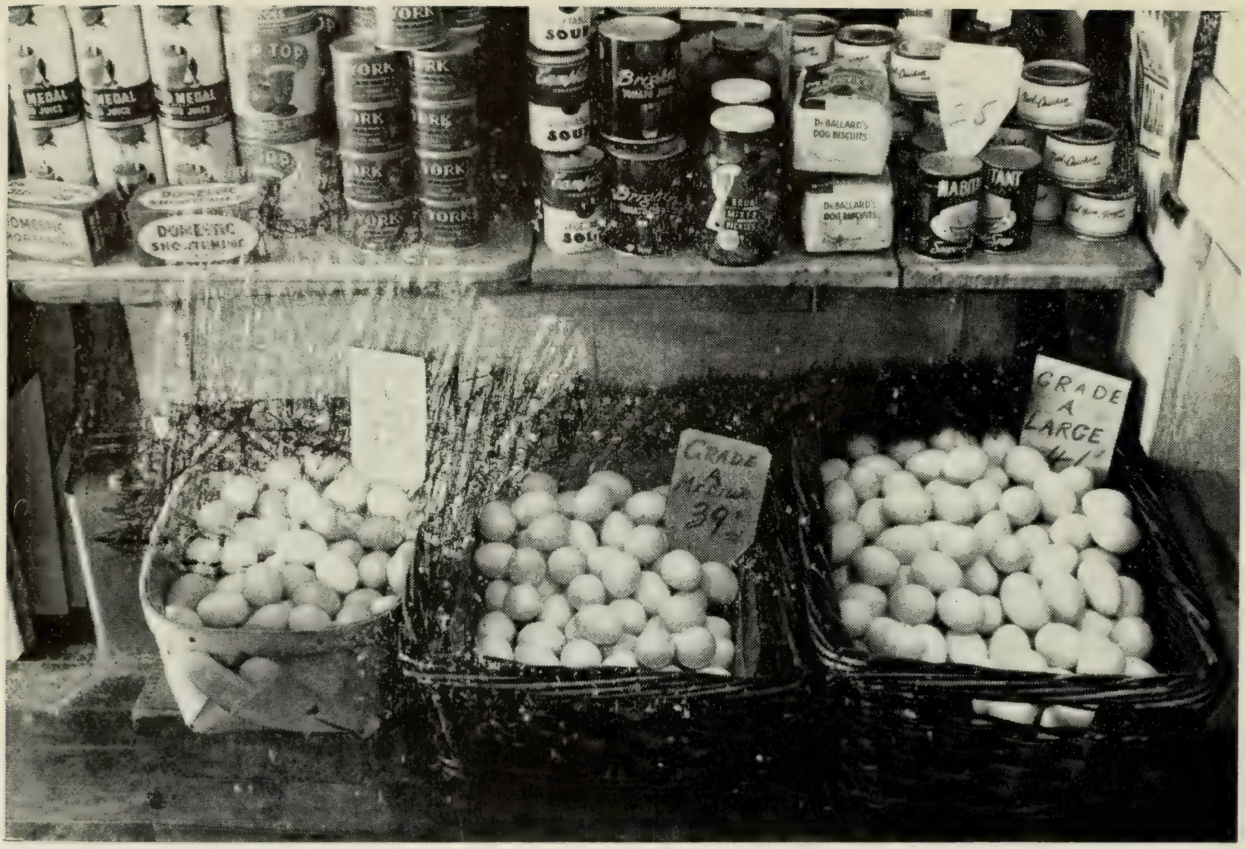


FIG. 32. Eggs exposed for sale in this way lose quality very rapidly, especially in a warm, dry store.

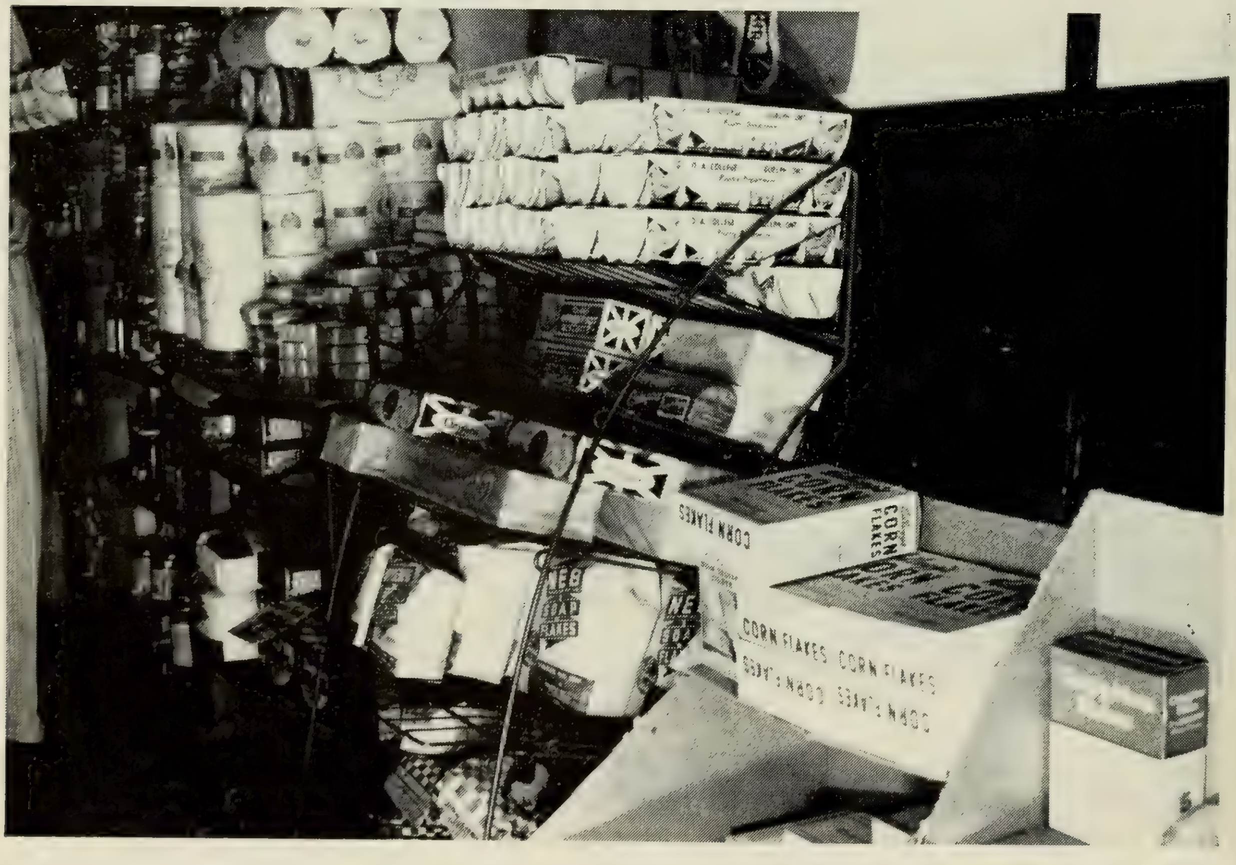


FIG. 33. Cartons facilitate handling, but do not materially protect quality when eggs so packed are exposed for sale for hours or even days in a warm, dry store.

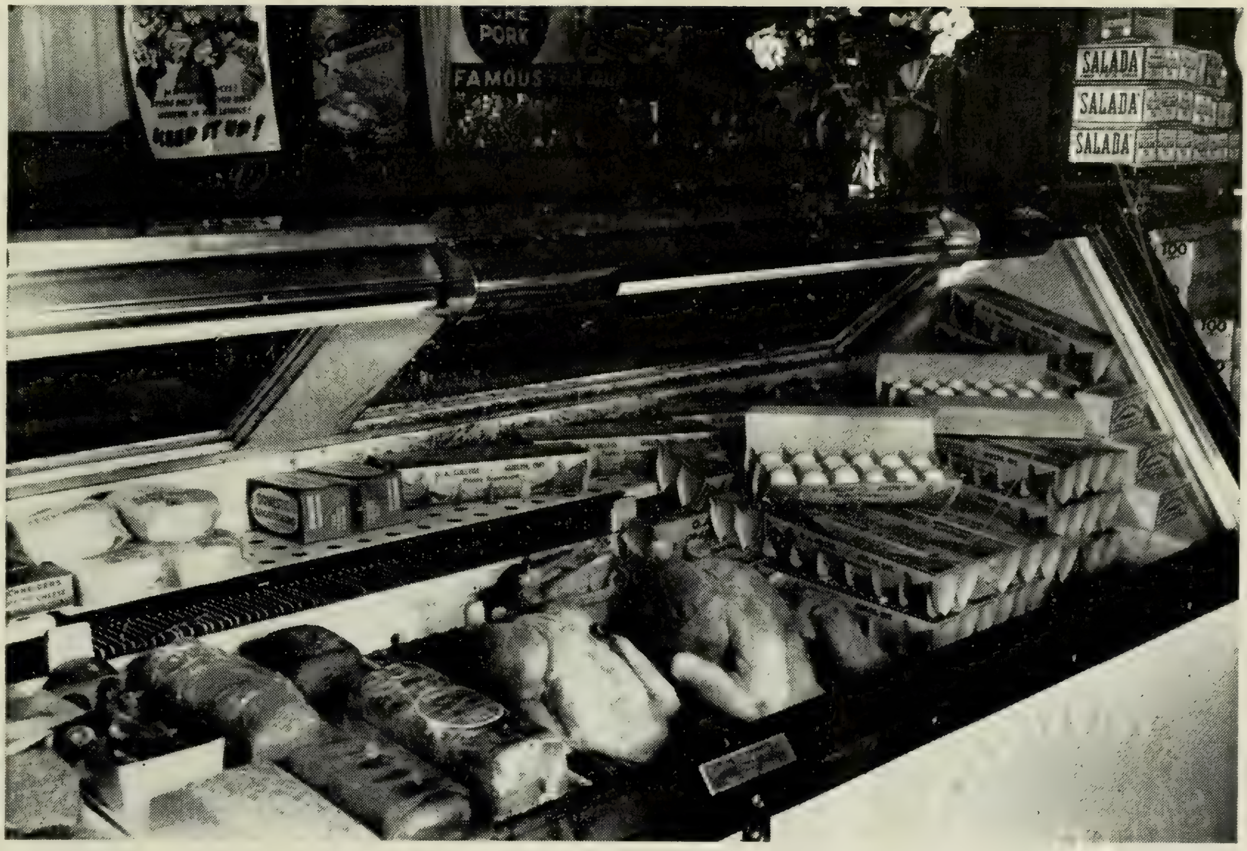


FIG. 34. Eggs should be kept in the refrigerator until sold, or exposed for sale in a refrigerator case as are most other perishable products.

FIG. 35. "The proof of the pudding is in the eating." Pleasure, satisfaction and health result from the consumption of quality eggs.

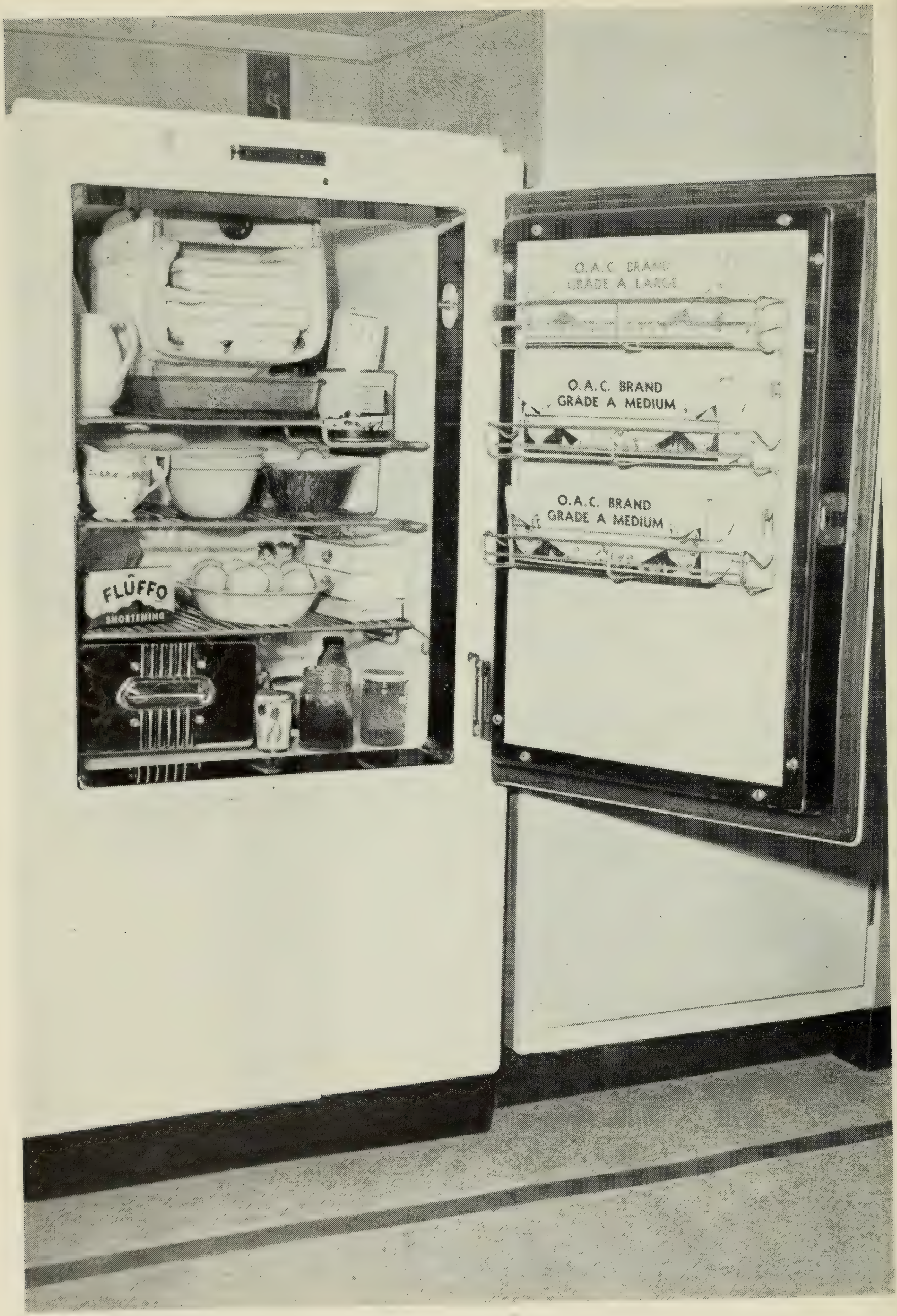


FIG. 36. After purchase eggs should be held in the household refrigerator until used.

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FRUIT MATURITY AND QUALITY

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By W. H. UPSHALL

HORTICULTURAL EXPERIMENT STATION
VINELAND STATION, ONTARIO

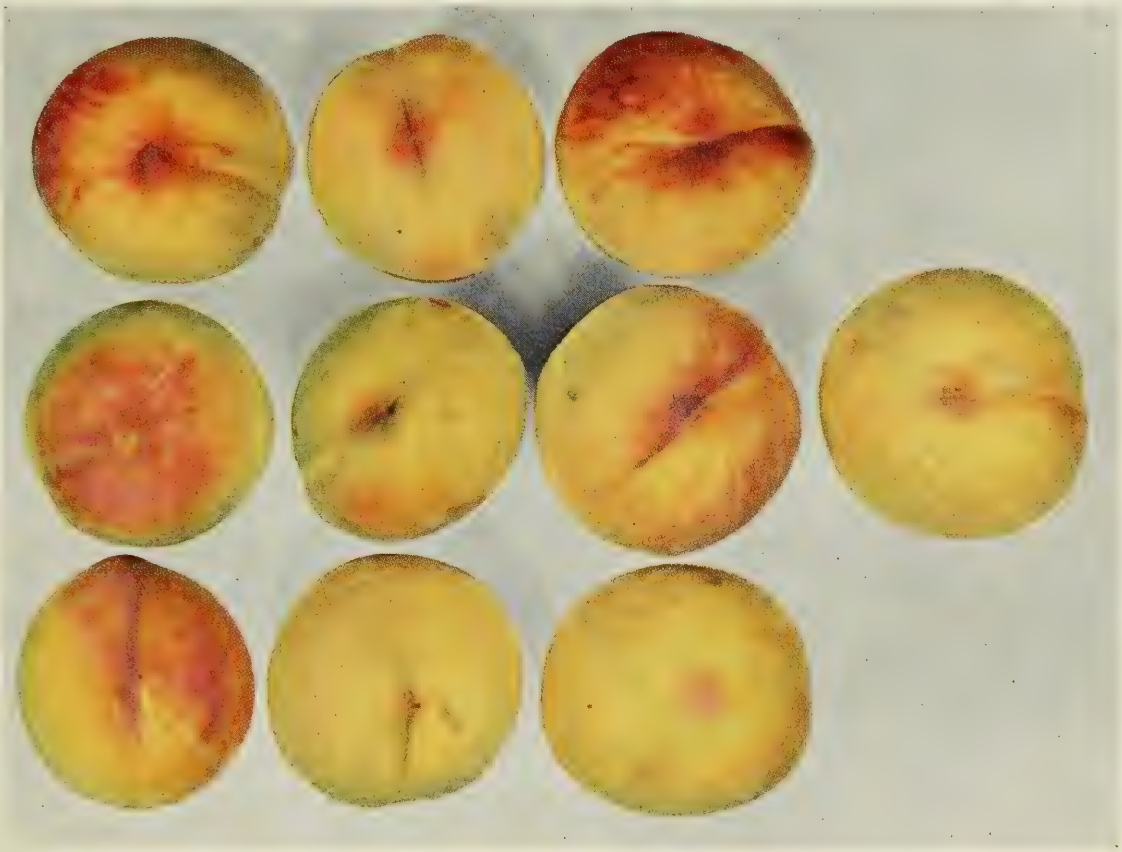

FIG. 3. Peaches, which had received the complete spray schedule for rot, as they appeared five days after picking, Sept. 10, 1945.

ONTARIO DEPARTMENT OF AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 447 • MARCH, 1946

CULTURAL METHODS FOR BETTER QUALITY PEACHES*

When we consider quality in peaches we are thinking primarily of the consumer. We ought therefore to stop and consider what the consumer would like to have in peaches. Consumer surveys conducted by the Ontario Fruit Branch in various Ontario cities have shown that the consumers appreciate quality and are willing to pay extra money to get it. If we assess their standards under the following heads the consensus of opinion would be:

Colour — a reasonable amount of red colour. In the mind of the consumer, red colour is associated with quality and analyses of fruit show that the association is usually justified.

Size — for canning, 2⅛ to 2⅜ inches; for fresh fruit, 2⅜ inches and up.

Quality — good, and preferably a freestone peach.

Maturity — ripe at time of purchase or within a day or two at the outside.

Keeping quality — rot under control in the orchard sufficiently that the fruit will hold up 2 or 3 days *after* it becomes "eating ripe."

What can the peach grower do in the orchard to ensure that the onsumers get what they want in peaches? It is not out of the way to ay that, by careful control of fertilization, cultivation, pruning, thinning, praying, picking, and packing, the grower can give the consumer a easonable degree of satisfaction. Only in this way can he increase the emand for the product and raise or maintain the price.

In the first place, peach trees of moderate vigour are required (B o C in Fig. 1). Excessive vigour (D in Fig. 1) means over-large peaches f poor colour (Fig. 2), inferior quality, fuzzy, slow to ripen, and of poor arrying qualities. Many orchards on the better soils in the Niagara istrict are in this class. A few, perhaps very few, are too weak in rowth (A in Fig. 1). These weak trees give fruit small in size and flat n flavour, with plenty of colour but of a dull hue. For mature trees, five ears and up, a terminal growth of from 8 to 16 inches at the ends of ain branches seems to be a reasonably satisfactory state of vigour.

FERTILIZATION

Excessive vigour results from a high-nitrogen condition in the tree. moderate supply of soil nitrates is desirable in spring and early summer ut is very undesirable in late summer. Heavy applications of manure nd nitrogen fertilizers are not generally recommended since they stimuate heavy and late growth. If 1945 terminal growth at the ends of main ranches is over 16 inches your orchard does not need nitrogen in 1946 ither in the form of manure or commercial fertilizer. If the growth is nder 8 inches more nitrogen is needed in the soil.

Address before the Annual Convention of the Niagara Peninsula Fruit Growers' Association, January 16th, 1946.

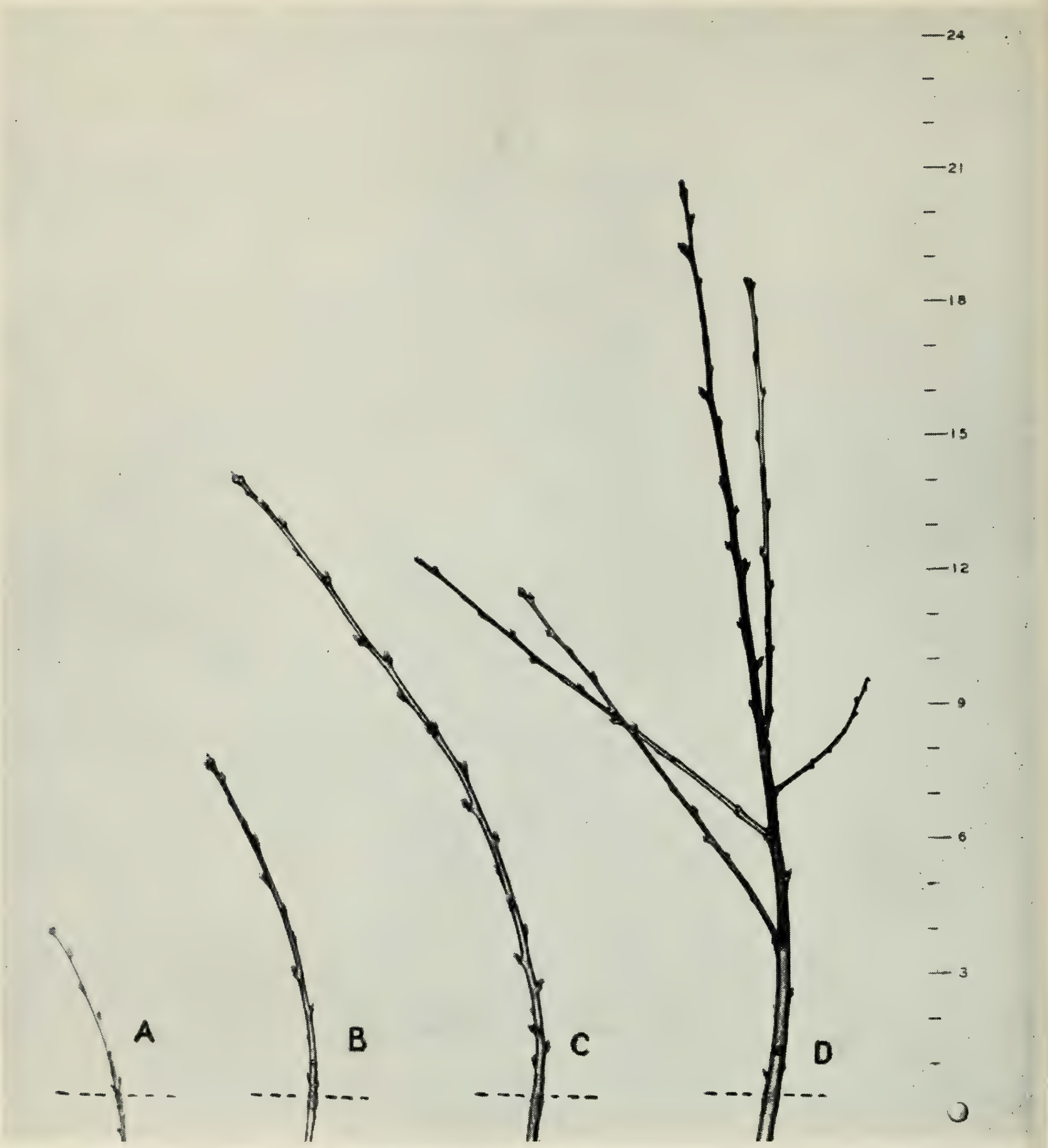

FIG 1. Degrees of vigour in mature peach trees as expressed by 1945 terminal growth (from broken line up). A—too weak; B to C—satisfactory; D—too vigorous.

CULTIVATION

In the spring and early summer, cultivation to keep down plant growth which otherwise would compete with the trees for nitrogen is very desirable. But, from mid-June a competing crop to take up surplus nitrates is wanted, so that tree growth will be stopped, thus permitting the sugars manufactured by the leaves to go into the fruit instead of into new growth. In orchards where growth is excessive the green-manure crop should be millet or weeds both of which keep the soil nitrates at a very low level. In such orchards also, earlier-than-normal cessation of cultivation is imperative if the fruit is to be of high quality.

TABLE 1 — EFFECT OF EARLY SEEDING ON SOIL NITRATES

FIVE-YEAR AVERAGES

Time of Seeding	Late July	Early August	Late August	Early September	
May 15	1	1	1	1	p.p.m.
July 15	12	8	5	4	p.p.m.

The effect on soil nitrates of early cessation of cultivation and seeding of green-manure crop was well illustrated in an apple orchard at the Experiment Station. Soil nitrates were determined at fortnightly intervals over a five-year period on plots seeded about May 15, and July 15. The figures for the 0-to-6-inch depth (Table 1) show that the growth of the green-manure crop started May 15 kept the nitrate supply at the low level of 1 part per million (p.p.m.) from late July to early September. In the plots sown July 15 the nitrates had accumulated to such an extent that they still registered 4 parts per million in early September. An excess of nitrates in late summer and early fall is detrimental to the colour of apples and all indications point to a similar effect on peaches.

PRUNING

Pruning reduces yield in direct proportion to its severity (Table 2). In its other effects on the tree, pruning acts like an application of nitrogen—delaying maturity, reducing red colour, but often increasing size.

A pruning experiment on three varieties which was started a year after planting, and which at the end of the sixth year was still in progress, may be used to illustrate some of the effects just mentioned (Table 2). Light pruning involved the removal of low drooping branches, also dead, dying, and very weak wood. The trees under the heavy heading treatment received the light pruning as above plus a heavy heading to an outward-growing lateral on the two-year wood. This treatment has reduced the height of the trees but at the expense of bearing area. Heavy heading has increased terminal growth over light pruning, 8 inches in 1945, but has reduced yields by 22 pounds per tree per year, 1944 and 1945 average. The crop under both treatments was a failure through frost injury in 1943, was normal in 1944, and light in 1945 through poor conditions for fruit setting. The maturity of the fruit has been delayed by the heavy heading treatment as shown by the much smaller proportion of the crop ready for harvesting at the first picking date, 20 per cent compared to 52 per cent for the light pruning treatment.

The trees given the heavy heading treatment have very strong growth in the tops and continue to grow late into the summer. The fruit is poor in colour probably partly due to excessive shading and partly to the sugars manufactured in the leaves going into growth extension rather than into the fruit. Low-sugar content of the fruit is usually associated with a deficiency of red colour on the skin. In addition, these dense trees resulting from heavy heading are slow to dry off after rains and heavy dews, and are therefore more subject to loss of fruit from brown rot.

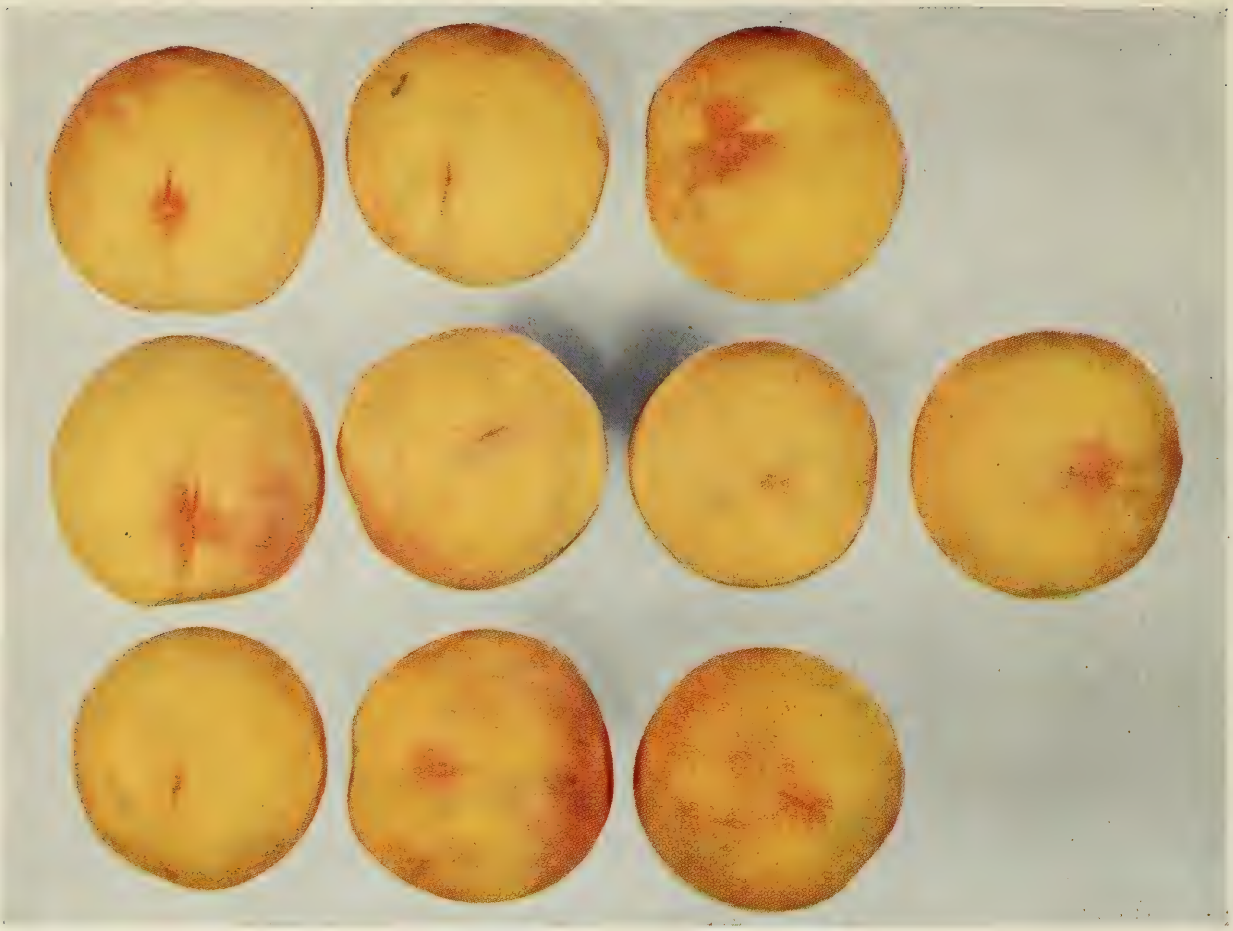

FIG. 2. Vedette peaches at the "eating ripe" stage. These peaches, grown on very vigorous trees, were lacking in appearance and quality.

TABLE 2 — PRUNING YOUNG PEACH TREES

FIRST SIX YEARS IN THE ORCHARD

	Light Pruning	**Heavy Heading**
Prunings per tree (Av.)	1.1 lb. per year	2.9 lb. per year
Terminal growth 1945	14 inches	22 inches
Yield (Av. 1944-45)	40 lb. per tree	18 lb. per tree
Amount 1st picking	52 percent	20 percent
Fruit colour	Good	Poor

A combination of heavy pruning, heavy nitrogen fertilization, and late cultivation can be very undesirable in the culture of peach trees. The trees themselves become more subject to winter injury and the fruit is late in maturing, excessively large, coarse, poor in colour and quality, and does not carry or hold up well. Early maturity of late-season varieties like Elberta ordinarily results in better quality because the chances of maturing in warm weather are greater.

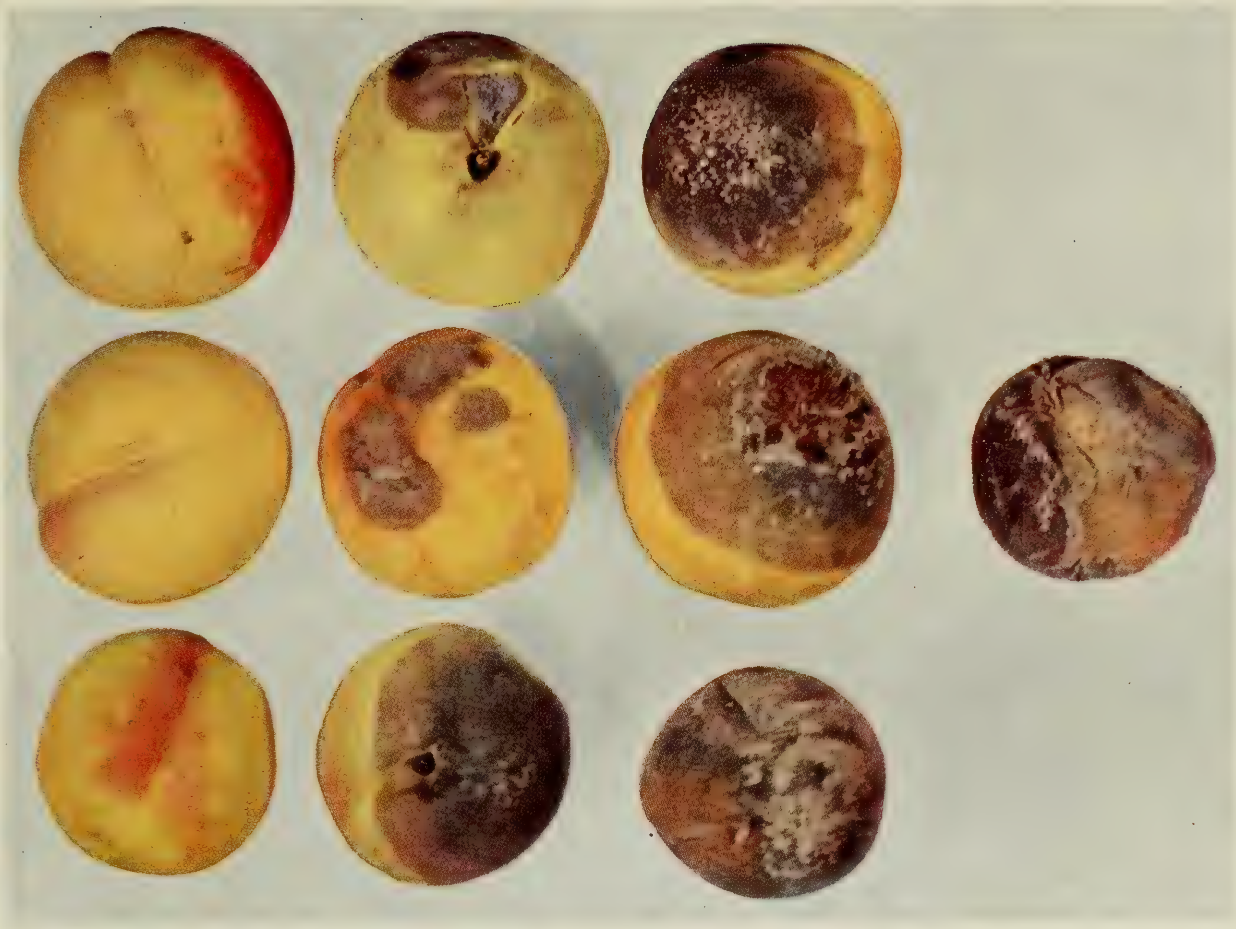

FIG. 4. Peaches, which were given only two of the four recommended rot sprays, as they appeared five days after picking, Sept. 10, 1945.

THINNING

If the maintenance of a high-nitrogen condition in the peach would make thinning unnecessary it would have its supporters. However, high vigour does not give sufficient fruit-size where the peaches are abundant, and consequently thinning is still a required operation.

The "total load" system of thinning is favoured at the present time. If you think your trees should bear about 200 pounds each and you want the fruits to average $2\frac{3}{8}$ inches in caliper (about 4 per pound) it is obvious that you should have about 800 peaches on the tree. A count of fruits left on a portion of the tree, say one main branch, will tell whether the thinning has been done properly. Occasionally the owner can check his thinning gang in this way or they can check their own work.

Because No. 2 peaches are of considerably less value than No. 1 peaches it is advisable to thin for a dry summer, that is, thin sufficiently to guard against failure to reach No. 1 size even in a dry season. This amount of thinning year after year also pays big dividends in an indirect way by helping to keep the tree from exhaustion through the production of an over-abundance of pits, the development of which draws heavily on the tree's mineral supply.

Thinning, by increasing the leaf area per peach, (Table 3) allows for the higher sugar content in the fruit associated with better eating quality.

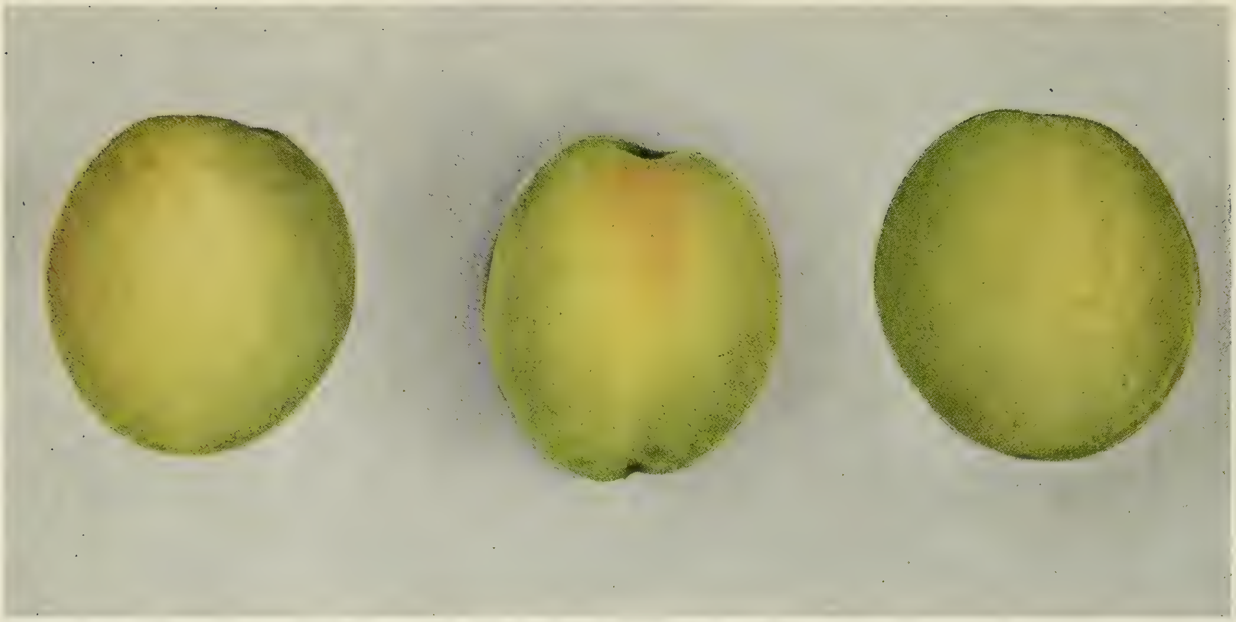

FIG. 5. Elberta peaches picked 10 days before optimum maturity.

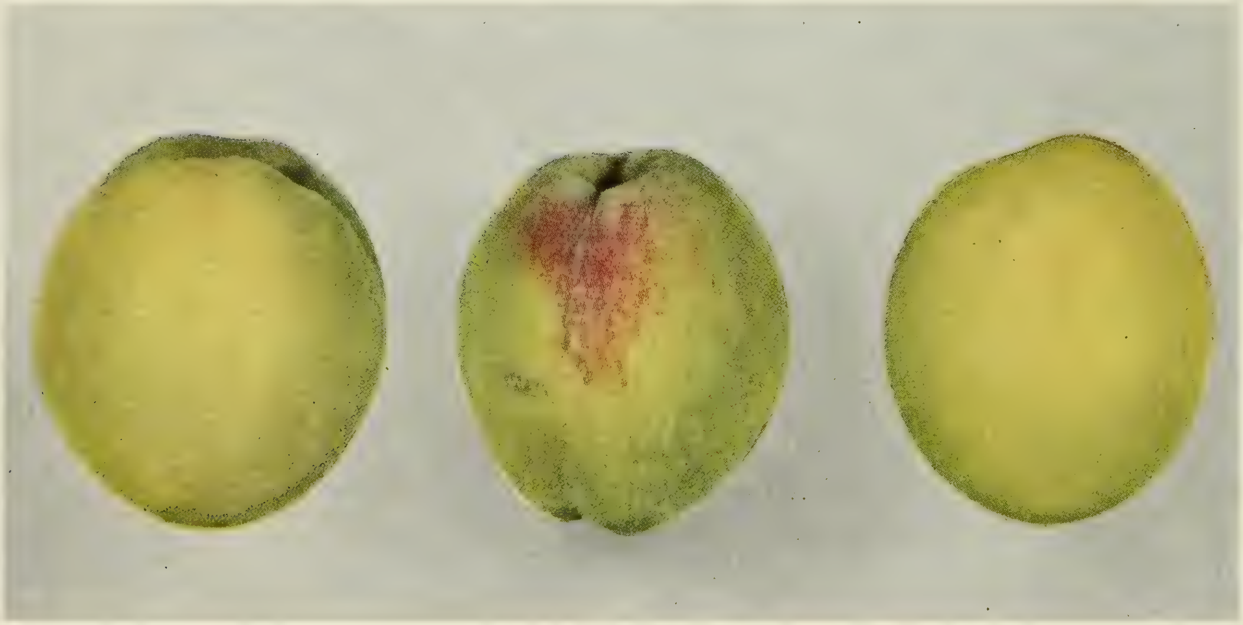

FIG. 6. Elberta peaches picked 7 days before optimum maturity.

An experiment with Elberta peaches reported by Weinberger illustrates the effect of thinning on size and quality of peaches. Some of his data is given in Table 3. Under the conditions of the experiment 5 leaves per fruit gave under-size fruits of poor quality; 20 leaves per fruit, peaches of good size and quality; and 75 leaves per fruit, over-size peaches of very good quality. For a maximum crop of good size and quality 20 leaves per fruit might be considered satisfactory. However, considering tree condition and future performance, Weinberger has suggested an optimum of 30 to 40 leaves per fruit under conditions similar to his experiment.

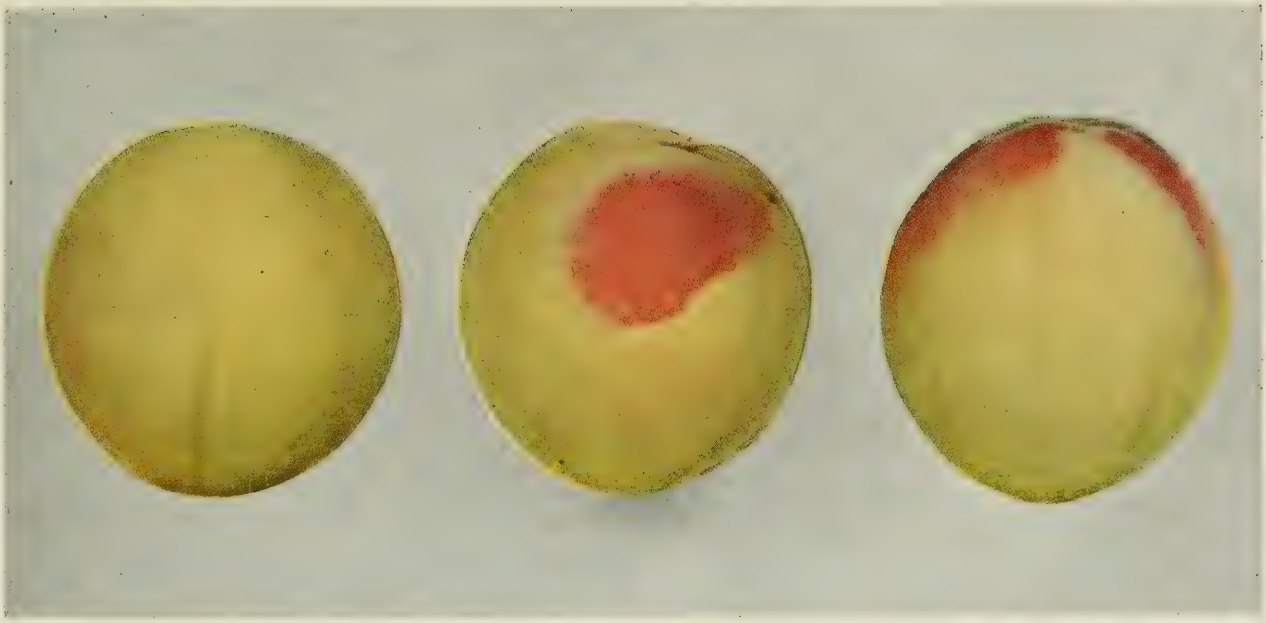

FIG. 7. Elberta peaches picked 4 days before optimum maturity.

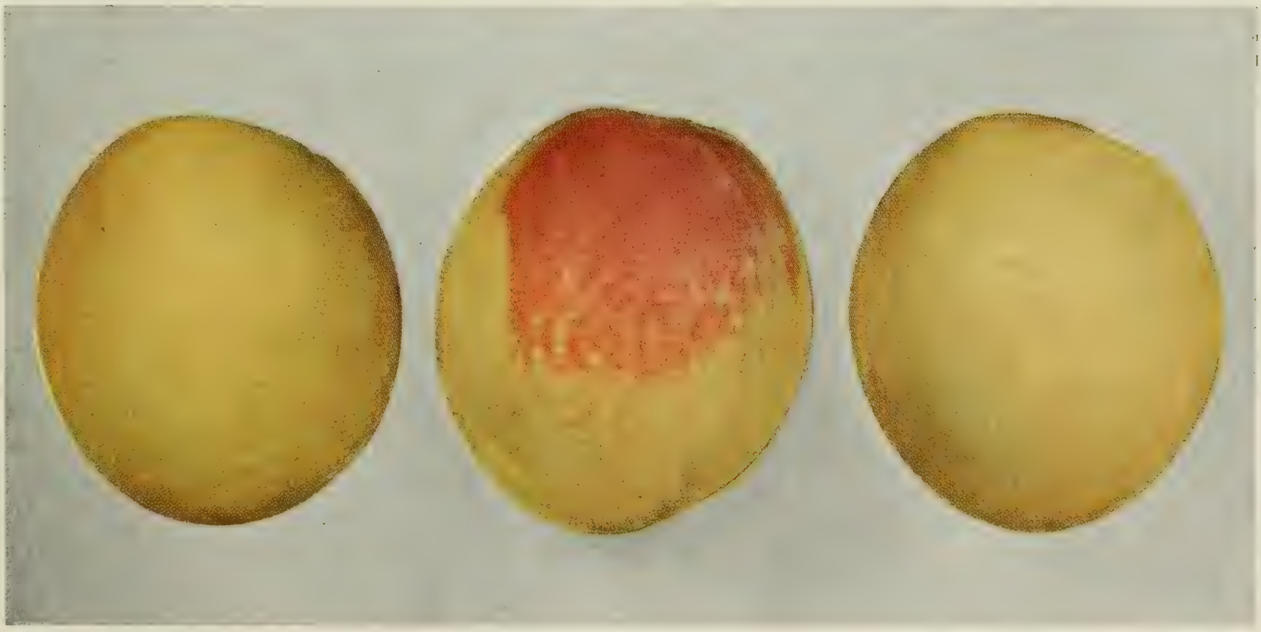

FIG. 8. Elberta peaches picked at optimum maturity. Three-year averages for the ten-day period prior to optimum maturity show increases of 28 per cent in tonnage and 11 per cent in sugar, a decrease of 20 per cent in acid, and an increase in red colour from 7 to 31 per cent of the surface.

TABLE 3 — EFFECT OF THINNING ON SIZE AND QUALITY OF PEACHES*

Leaves Per Fruit	Average Size Inches	Total Sugars Per Cent
5	2	5.4
20	2⅜	7.6
75	2¾	9.0

*Weinberger, J. H. Proc. Amer. Soc. Hort. Sci. 28: 18-22 (1932).

SPRAYING

Any spray which keeps the foliage in good condition, free of leaf curl for instance, and does not cause appreciable spray injury, will enhance the quality of the fruit. Since rot studies are in the field of the plant pathologist it is not proposed to enter into a discussion on control. Suffice it to say that our shipping tests have shown that all of the recommended rot sprays should be applied, that they should indeed be considered as the *minimum* number. The very common omission of the prepick spray is one of the fundamental causes of complaints from consumers that the wastage in Ontario peaches is excessive (Fig. 3, front cover, and Fig. 4).

PICKING

There is no orchard operation in which timing is more important than in picking. As a rule three pickings will be required, sometimes two, sometimes four, depending on temperature conditions. For each picking the grower must decide when there are enough sufficiently mature fruits to warrant the labour of going over the trees. Picking is a job which should not be rushed, certainly not a piecework proposition. There is no better index of maturity for orchard use than the disappearance of the green from the ground colour of the peach (Figs. 5 to 8) and the pickers should have time to see the ground colour of each fruit. Red colour is not a reliable index of maturity. Picking is definitely not a job for a colour-blind person. The growers should insist on picking above a certain ground colour even to the extent of having pickers identify their baskets by dropping a numbered card in each one.

The whole inner surface of the hand should contact the peach in the picking operation. Picking in finger tips only is not permissible because it is very likely to result in bruises which in a few hours become discoloured, thereby reducing the attractiveness of the peach.

Just because your neighbour starts to-day to pick Vedette peaches is no assurance that your Vedette peaches are ready to pick, even if his timing is correct. If he has "low-nitrogen" trees and you have "high-nitrogen" trees your picking may be as much as a week later than your neighbour's.

Only with the Elberta variety is there any appreciable danger of dropping before the green has disappeared from the ground colour of the peach. The danger of loss from windfalls in varieties other than Elberta has been greatly exaggerated. The loss in Elberta can be appreciably reduced by close picking to ground colour, that is, picking frequent enough that no peaches are allowed to stay on the tree so long that they lose all of the green in their ground colour.

VARIETY

It is generally recognized by growers that varieties differ in their eating qualities. A good deal of the preference is a matter of personal taste, but for those consumers who suffer from periodic attacks of acid indigestion, a low-acid variety is preferred. Our work on maturity shows that there are appreciable differences in acid content of varieties picked at optimum maturity and tested at the best eating stage. The three-year averages for Veteran, Elberta and Jubilee are 0.9, 1.2, and 1.3 per cent acid respectively. In these same varieties the differences in sugar content were insignificant.

FRUIT MATURITY FACTS AND FANCIES*

Many reasons are given by growers for picking their fruit prior to the time of optimum maturity. All have to do with the fear of direct and immediate financial loss. In thinking of possible personal loss the grower sometimes forgets that the consumer is also subject to loss and that the latter can "make or break" him by acceptance or rejection of his product—the customer is always right. For several years in the Ontario fruit industry it has been a seller's market. It is generally conceded, however, that it will not always be so and that, in heavy crop years particularly, selling may be a much more difficult problem. This will be a time when quality of fruit and an attractive pack will bring returns more than commensurate with the extra labour involved. In that connection it should be stated that quality is increased only while the fruit is on the tree, not in the basket.

The investigations sponsored by the Fresh Fruit Marketing Committee of the Niagara Peninsula Fruit Growers' Association and carried on jointly by the Ontario Fruit Branch and the Horticultural Experiment Station show conclusively that the customers appreciate quality and are willing to pay more to get it. If our marketing set-up was such that the extra returns obtained for a quality product could be remitted to the individual growers, unquestionably there would be a steady improvement in *all* packs. Conversely, if losses from rot suffered by retailers and consumers could be subtracted from the grower's receipts a vast improvement in the control of brown rot in the orchard would surely result. In that connection, retailers and consumers could play an important part in the improvement of packs by reporting to the shipper or grower whose address is given on the basket, the condition of the fruit.

Growers have given their own reasons for picking fruit before it reaches an optimum maturity consistent with satisfactory carrying qualities. They fear loss from any one or several of the following factors: (1) price drop, (2) rot, (3) windfalls, (4) splitting, (5) birds, (6) overmaturity. Each factor will be considered separately and in the light of investigations carried on at Vineland during recent years.

PRICE DROP

This is primarily an economic problem rather than a horticultural one. Nevertheless it is one that horticulturists cannot ignore. To so guide growers in their planting program that there will be a steady flow of fresh fruit rather than an excess at one period and a scarcity at another should constantly be kept in mind. The planting survey taken through the Niagara Spray Service a few years ago was an attempt to get information along this line (see page 11, Ontario Department of Agriculture Bulletin 430. Fruit Varieties). Crop reports together with market information should show when a glut is likely to occur and provision should be made for wider distribution, cold storage facilities, or an intensive advertising campaign, in order to prevent undue price depression.

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*Originally printed in January, 1946, issue of Canadian Horticulture and Home Magazine (Growers' edition).

The fear of a price drop has probably been over-rated for *on the average,* there is just as good a chance of a price rise. Furthermore green fruit will in itself depress the market and it will rise again with difficulty. This was the case in Ottawa in 1944 when green Shiro plums could not be cleared in time for the better quality Shiros available at a later date. The normal increase in yield due to size increase of the fruits is from one and a half to five per cent per day, the rate depending on the kind and variety of the fruit. In addition to this tonnage increase there is also a steady improvement in grade, attractiveness, and quality. These factors should be considered as an off-set to a possible price reduction.

ROT

With concentrated stone-fruit plantings as they exist in the Niagara Peninsula, brown rot is sure to be a major problem. In every season there will be some brown rot and in some years, under weather conditions favourable for its development, it will become a very serious menace. Growers should bear in mind that a small percentage of loss in the orchard and packing house is certain to mean a loss of several times this amount to the consumer. One orchard from which samples of Elberta peaches were obtained in 1945 showed about 5 per cent of the peaches on the trees with rot spots. Only non-spotted peaches were packed but by the time they were ready for use in the kitchens of Toronto purchasers the wastage was about 50 per cent.

Surveys show that many growers are omitting some of the rot sprays, particularly the prepick spray. The rot sprays as given in the spray calendar and enumerated periodically by the Spray Service should be considered as a *minimum* number, more sprays or dusts being applied under bad weather conditions—frequent rains and hot humid days. Nothing is so annoying to the housewife and so dampens her enthusiasm for further supplies than the loss of fruit from rot before it is usable. By strict adherence to recommended practices for brown rot control—removal of dead wood and mummies at pruning time, thorough cultivation before blossom time, and a *complete* spray schedule—brown rot can be almost eliminated as a factor influencing time of picking.

Two reasons are given for the omission of the prepick spray—(1) cannot get into the orchard with spray outfit, (2) too busy. The ultimate answer to the former is wider planting distances, and a recent survey in the Niagara District shows that there is such a trend. However, this does not relieve the situation in orchards now 16 by 20 feet, 18 by 18 feet, and 20 by 20 feet. Dusters and low-set spray machines will be helpful but even then the removal at pruning time of low drooping branches will be necessary. The fruit borne on these branches is often poor in quality and late to ripen—not any considerable loss.

The "too busy" excuse(?) is basically weak and short-sighted. Investigations at the Plant Pathology Laboratory at St. Catharines have shown that the prepick spray is essential both as insurance against direct loss in orchard and packing house and as further protection for the consumer. There has been an admitted shortage of labour during the war years but with the hope of more help in 1946 this spray (or dust) should be applied without question to sweet cherries, peaches, and plums.

WINDFALLS

Leaving apples out of the picture, loss from windfalls occurs most often in pears though it may be quite a consideration in Elberta peaches.

In 1944, daily records of windfalls under two mature Bartlett pear trees were taken. One tree was in a sod-mulch orchard, the other in a cover-crop orchard. Measurements of individual pears taken every second day were used to estimate the crop increase in the final week before optimum maturity. The balance sheet for this period is shown in Table 1:

TABLE 1 — BALANCE SHEET FOR FINAL WEEK BEFORE OPTIMUM MATURITY OF BARTLETT PEARS, 1944

		Sod-mulch Orchard		Cover-crop Orchard
Crop Increase		14.0 lb.		12.0 lb.
Windfalls (non-wormy)		2.5 lb.		2.0 lb.
Windfalls (wormy)	6.0 lb.		13.0 lb.	
Net Increase of Good Fruit		11.5 lb.		10.0 lb.

Some growers might easily have become alarmed by the number of windfalls under these trees, particularly in the cover-crop orchard and, as a result, picked the pears before the optimum maturity stage. Had this been done, there would have been a loss of tonnage of one and one-half per cent for every day that picking was previous to the optimum maturity date. The windfalls of good fruit were quite insignificant up to the optimum maturity stage. The above figures serve to illustrate a well-established fact, that wormy fruit ripens and drops earlier than good fruit. By the optimum picking time for uninjured fruit a good proportion of the wormy fruit has dropped—a fortunate condition since it saves the handling of fruit which normally is not saleable. The dropping of wormy fruit can not be recommended as a guide for optimum picking time. On the other hand, when good fruit begins to come down in proportions as great as size increase, about one and one-half per cent per day of the estimated pear crop, then the faster the crop is picked the better, with respect both to the quantity and quality of the crop.

Peach growers would do well to keep in mind that peaches increase in weight from 3 to 5 per cent per day. A possible loss from wind of 2 per cent per day, for instance, would not in itself justify picking—a simple arithmetical conclusion. In addition to size increase there is also a rapid improvement in grade, appearance, and quality as shown in figures for the Veteran variety (Table 2).

TABLE 2 — INCREASE IN QUANTITY, GRADE, APPEARANCE, AND QUALITY IN THE FINAL WEEK BEFORE OPTIMUM MATURITY (O.M.)

	Yield lb. per Tree	% above No. 2 Grade	% of Surface with Red Colour	At Ripe Stage		
				Total Sugars	Total Acids	Taste
Picked 7 days before O.M.	156	73	14	5.7	1.07	poor
Picked at O.M.	200	94	44	7.0	.91	good

In most peach varieties there is little danger of loss from windfalls up to the time of the disappearance of the green from the ground colour. With the Elberta variety however, because of its tendency to drop, it is advisable to pick while there is still a trace of green in the ground colour. There is more need of picking to colour in Elberta than in the other varieties. Picked too soon they are notoriously poor quality and left too long they are likely to drop. The 1945 greater-than-usual tendency to drop while quite green was probably in part associated with the prevalence of the larvae of the Oriental fruit moth, wormy peaches as well as wormy pears dropping before the good fruit.

SPLITTING AND BIRDS

Loss from splitting and birds applies particularly to sweet cherries though it is not unknown in certain plum and peach varieties.

In 1945, records were taken on splitting and bird damage in a large orchard near Vineland. The figures given in Table 3 show that, in three varieties out of four, there was a net gain through leaving the fruit on the tree up to the optimum maturity stage. During the period in which records were taken there was relatively favourable weather for splitting but the worst period, the week-end of July 15, came after the optimum maturity time for this orchard.

TABLE 3 — BALANCE SHEET FOR FINAL WEEK BEFORE OPTIMUM MATURITY OF SWEET CHERRIES IN 1945

Variety	Crop	Loss of Fruits by Count %			Size Increase by Weight %
Black Tartarian	Heavy			Gross	32.0
		Splitting	0		
		Birds	2.0		2.0
		Net gain from leaving on tree			30.0
Schmidt	Light			Gross	33.0
		Splitting	6.0		
		Birds	10.0		16.0
		Net gain from leaving on tree			17.0
Windsor	Heavy			Gross	19.0
		Splitting	23.5		
		Birds	3.5		27.0
		Net loss from leaving on tree			8.0
Hedelfingen	Heavy			Gross	13.0
		Splitting	5.0		
		Birds	0.5		5.5
		Net gain from leaving on tree			7.5

The figures in Table 3 are for one season and one orchard and are therefore only indicative. For this one set of conditions however, they show that it would have been unprofitable to pick Black Tartarian, Schmidt, and Hedelfingen before the optimum maturity date. The loss incurred by deferring the picking of Windsor to the optimum maturity stage was largely due to splitting caused by rains in the late afternoon of two days, July 6 and 7. At these times the fruits were still about five days short of the optimum maturity stage. The cherries in the tops of the trees were riper and more damaged by splitting and birds than were those in the lower parts of the trees.

Growers who sell half-ripe sweet cherries for processing should take into account the loss of tonnage through early picking. On the average it will amount to one and one-half to two per cent per day. This loss through early picking should be taken into account in deciding whether to sell to processing or fresh-fruit markets, but over against it one must put the advantage of a lengthening of the total picking period for a given variety where fruit can be sold for both purposes.

OVERMATURITY

When there is a short supply of labour the fear of overmaturity can be of high importance. In 1946 and thereafter it may be a much less valid argument for early picking than it has been of recent years. Lately growers have expressed the fear that, with limited labour, the fruit would mature faster than they could have it picked, particularly during a heat wave. Consequently they felt disposed to keep "more than up" with the picking as a measure of insurance against loss from overmature fruit. Overmaturity may be expressed in the development of soft centres in ripening Bartlett pears or in poor handling qualities in peaches and some plum varieties.

Daily weather predictions for 48 hours in advance (CBL Farm Broadcast) take away some of this fear. Adequate precooling facilities to quickly arrest the ripening process can be very effective in preventing losses from overmaturity. Then too, the Vineland shipping experiments have indicated that many growers do not realize how soft a peach or plum may be and still carry to nearby markets in reasonably good condition. Surveys have shown that the consumers, for the sake of getting ripe fruit, do not object to a moderate amount of bruising. Furthermore the impending increase in highway traffic is going to result in an expanding market for ripe peaches and plums at roadside stands.

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LAWNS

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LAWNS

by

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A good lawn is a prime feature in the development and improvement of the home grounds. It is a chief part of the foreground and base of every landscape planting. It provides the setting for flowers, trees, and shrubs and enhances the beauty of the home.

Painstaking care in establishing a lawn is essential. The increased labour and expense which may be involved in starting right is well repaid in the future since maintenance costs and labour will be less than in the case of poorly constructed lawns. The lawn, like the house, is no stronger than its foundation. A good foundation for grass means a favourable soil environment. This can be provided when the seedbed is being prepared.

ESTABLISHING THE LAWN

Subsoil Considerations

In building a new house, the owner and the building contractor should also plan for the lawn. Where subsoil is excavated for the cellar, provision for proper disposal of such soil can be made in advance. Subsoil should not be spread over the surface of the area to be used as the lawn, nor should grading or levelling in which the topsoil is covered and the subsoil exposed ever be permitted.

If much grading and levelling are required, the contractor should scrape aside the top 5 or 6 inches of soil and save it for replacement. It took nature 5,000 to 20,000 years to make 6 inches of topsoil, and so it should be carefully preserved. Unfortunately, when a house is built, the topsoil on the site is frequently hauled away and the lawn area covered with subsoil (which lacks good texture or structure and organic matter) from the excavation. It is then necessary to secure good topsoil to cover the area to a depth of 5 to 6 inches. It may be necessary to enrich or remove some of the poor soil before the topsoil is added.

Drainage

Lawns must be well drained. This applies to both underdrainage and surface drainage. Surface drainage can be taken care of by proper grading. No low areas should exist since grass seed can be washed into any depressions by rain or during watering. Also, ice lying in hollows will smother grass.

When the roots do not function properly this is often because of the compactness of the soil which results in poor underdrainage and also in poor aeration, i.e., the lack of available oxygen in the soil. The problem of surplus water may be further increased by seepage from nearby areas converging on the property.

Grateful acknowledgement is made to John A. Weall, Department of Horticulture, O.A.C., for many helpful suggestions.

Installing tile drains before the grade is completed is a good investment if the essential drainage cannot be obtained otherwise. It makes wet, soggy places drier, aids in removing excess rainfall quickly, and so helps aerate the soil. Lines of 3 to 4-inch tile 15 to 25 feet apart, 2 to 2½ feet deep, and with a minimum fall of 2 inches in 100 feet, usually provide adequate underdrainage where it is needed. The effect of tile underdrainage may be slow if the tiles are covered by heavy clay or fine-textured basement soils, and so the more compact the subsoil the closer the lines of tile should be. The efficiency of tile drains is increased by covering the tiles with a layer of cinders or gravel. A piece of cracked tile, or other suitable material, placed over the tile joints will prevent them from clogging up. The open end of the tile system should be screened with wire meshing to keep birds, mice, and rats from nesting there. The outlet for the tile system may connect with the storm sewer or the downspout drain, or simply empty into the street. Approval of city authorities is necessary for some types of outlet installations. In the event of no storm sewers being available, a sump can be constructed at the edge of the lawn and tiles connected to it.

Fig. 1. A lawn for rest and recreation.

It is a good plan to use rough cinders under the 6-inch layer of topsoil for an overall drainage scheme.

Grading and Levelling

On every lawn there are at least two fixed grade points: (a) the grade line of the house, and (b) that of the curb, sidewalk, or roadway, or possibly trees which cannot be altered. In the grading, harmony and adaptation to adjacent property should be sought so that the home is distinctive but not too conspicuous.

It is desirable that the lawn should slope gradually from the house in all directions. The slope should be sufficient to drain off excess surface water but not so steep as to cause rapid runoff, e.g., a fall of ¼ inch to the foot.

Terraces should be avoided if possible, as terraced lawns dry out very quickly in warm, dry weather, are costly, and difficult to establish and maintain. But, where the grade away from the house drops more than 1 foot in 16 it is best to construct a terrace or a series of them, which may be supported by retaining walls. Lawns laid out on such terraces are easier to maintain and usually are more attractive than are steep ones. Also, they can be used more effectively for family pleasures. There are cases where the grade and space permit gently sloping banks to be an attraction.

To gain an idea of the finished contour, grade stakes may be set at intermediate points between the fixed grade points after the ground is dug or plowed, the rough grading done, and any necessary tile drains laid. The stakes are connected by tightly stretched strings. The line thus formed is viewed from a distance and raised or lowered to the desired slope. Then, the height on each stake is marked, the lines are removed, and the surface over the entire area is made to the established grade. This operation can be accomplished on rough, uneven ground by using T-shaped sighting rods.

Soil and its Preparation

An important property of a good soil is good physical condition, and this condition depends upon the size of the soil particles and the presence of organic matter. A predominance of fine particles, as in clay, produces a heavy compact soil, which is undesirable. Large soil particles, as in sand, produce an open soil condition with poor water-holding capacity. A loam soil is a balanced condition between large and small particles in combination with organic matter. Enough sand is present to provide the large air spaces necessary for adequate drainage. Sufficient small particles improve the water-holding capacity. A predominance of large soil particles in such a mixture produces a sandy loam, whereas a clay loam consists of a predominance of small particles.

Addition of organic matter gives the following beneficial effects:

1. Improves the soil texture, making heavy soils lighter and more friable and giving more body to light, sandy soils.

2. Improves the drainage and aeration of heavy soils and increases the water-holding capacity of light soils.

3. Helps provide a proper medium and food supply for essential soil micro-organisms. In soils the nutrient and water-holding capacity is increased.

4. Liberates "plant food" during decay.

5. Assists the soil in holding nutrients against leaching.

The chief sources of organic matter are manure, leafmold, compost, peat, and green-manure crops. Manure, where obtainable, is preferable because it not only improves the soil structure but also adds to the fertility. It should be applied at the rate of ½ ton (1 to 2 cubic yards) to 1,000 square feet and worked into the soil several weeks before seeding. Any weeds which appear meantime will be killed during the final preparation of the seedbed. Cow manure may be best for light soils and horse manure for heavy soils. Homemade composts of grass clippings, tree leaves, or spent mushroom soil are also good.

Granulated peats may also be used to supply humus, and such materials are particularly useful on clay soils. With dry peat, much watering is necessary until the peat becomes saturated; otherwise moisture is drawn from the surrounding soil and the formation of definite layers results. Extremely acid peats may be toxic to turf. On large areas, the humus in the soil may be increased by turning under a green-manure crop.

Soil Reaction

Most lawn grasses thrive on slightly acid to neutral soils. Usually pH* values below 5.5 are unfavorable for bent grasses and fescues, and values below 6.0 generally are unsuited for Kentucky bluegrass.

Lime need not be applied unless the soil is known to be too acid for good growth of grass. If used, it is applied uniformly over the soil surface since the penetration is downward and not lateral. For the best distribution throughout the soil, half the required lime is spread before forking or spading; the remainder is applied on the prepared surface and raked into the soil. Fertilizer and organic materials may be applied in like manner along with the lime. Even though lime is added when the seedbed is prepared, it is often necessary to continue liming periodically. Lime losses occur through leaching during periods of heavy rainfall and also through the removal of excess clippings.

Finely ground limestone usually is the best liming material. Coarsely ground forms of lime do not penetrate the soil fast enough to be of much value. Hydrated lime, unless carefully applied, may cause leaf burning, especially on moist grass blades; another disadvantage for surface applications is its tendency to cake and harden on the soil and thus become ineffective.

GROUND LIMESTONE REQUIRED TO CORRECT SOIL ACIDITY

Soil	Limestone required to raise the soil pH to 6.5 on the basis of 1,000 square feet		
	Sandy soil	*Loam soil*	*Clay soil*
	Lbs.	Lbs.	Lbs.
4.0	100	150	200
4.5	90	135	180
5.0	75	110	150
5.5	50	75	100
	25	50	75

Fertilizer

Most soils require fertilizer if a satisfactory lawn is to result. 20 percent superphosphate lightly raked in just before seeding, or sodding, at the rate of

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*The degree of acidity is measured in soils by the pH scale. Soils that are neutral (neither acid nor alkaline) are classed as pH, 7.0. If pH is less than 7.0 the soil is acid, and if more than 7.0 it is alkaline.

15 to 25 pounds per 1,000 square feet encourages root growth and assists materially in obtaining a good stand of grass. An alternative treatment is to apply 20 to 25 pounds of 4-12-6 or similar "complete" fertilizer which provides a balanced supply of nutrients for root and leaf growth. If manure is applied in combination with a complete fertilizer the nitrogen content can be reduced slightly by applying 0–14–7 or 2–12–6.

The fertilizer is spread evenly over the soil prior to the final raking of the seedbed. Too much fertilizer in one spot may injure seed germination. A uniform spread by hand is obtained by dividing the area into smaller areas, weighing out the proper quantity of fertilizer for each small area, and applying it to each of the smaller plots separately. The use of fertilizer distributors will insure that the fertilizer is applied evenly. (The use of fertilizer on established lawns is discussed later).

Seedbed Preparation

The final preparation of the seedbed should start 2 or 3 weeks before the most favorable time for sowing. The soil should be stirred occasionally during these 2 or 3 weeks to destroy the weeds that have started. The subsequent results will fully justify great care in putting the seedbed in the best possible condition. The seedbed should be firm, free of depressions and finely pulverized at the surface and thoroughly stirred to a depth of 2 inches. At seeding time there should be no lumps on the surface larger than a grain of wheat, and most of the soil should be as fine as sifted ashes. This condition is obtained by repeated rolling and raking, or by dragging a heavy plank or iron mat back and forth.

A newly graded soil should be allowed to settle before sowing grass seed· When the soil is very loose, heavy watering may be necessary to settle it. This watering also serves to show any low areas and insures an adequate supply of soil moisture below the seedbed. For the final smoothing it is often convenient to use a rigid, straight-edged board fitted with a long handle an equal distance from either end made rigid by braces. The board is pulled with a shearing motion across the surface, thus scraping off the high spots and dropping the soil into the depressions.

In many cases it is important after seeding that the ground be rolled with a 300-pound roller, though a lighter one may be used first to firm the ground against footprints and turning movements. This work should be done when the ground is not wet, so that soil will not stick to the roller. For best results, the ground should be thoroughly watered within 24 hours after rolling. In doing so, it is well to stand at the side with the hose nozzle to avoid dragging the hose over the prepared ground.

Where a rotary tilling machine is available, all the lime, fertilizer, and organic material can be applied together on the surface before the soil is worked. This type of machine completely mixes all materials throughout the soil area to a depth at which the machine operates.

LAWN GRASS SPECIES

Kentucky Bluegrass

(*Poa pratensis*)

This is the most widely adapted and most valuable of all lawn grasses. It is hardy, spreads by means of underground rhizomes or shoots, and produces a comparatively dense, medium-textured, serviceable, and long-wearing sod. During active growth the foliage is a dark, vivid green. Though this grass makes its best growth during cool, moist weather and languishes during the warm, dry months, it is not permanently injured by heat or drought if it is well established. It is the basis of most lawns.

Canada Bluegrass

(*Poa compressa*)

This forms an open, coarse sod with a poor, light, bluish-green color. It is highly drought-resistant and capable of growing on poor, dry, sandy or gravelly soils of rather low fertility, and is useful in mixtures when it is impossible to provide moisture and suitable cultural conditions necessary for Kentucky bluegrass. It is comparatively resistant to wear and has a place in mixtures for playgrounds and similar roughly-treated areas. It spreads by means of rhizomes.

Annual Bluegrass

(*Poa annua*)

This species is prevalent throughout northern turf areas. It is so low growing that the mower leaves many of the seed-heads untouched and the self-sown seedlings quickly appear. It is an invader of bentgrass putting and bowling greens and fairways. It is an "in-between" grass after the bluegrasses and fescues disappear and before the bents take over. Its growth requirements are much the same as for bents. It can be kept out of bent greens by: (a) using bents which grow early in the spring and by sound management practices which maintain vigor and aggressiveness; (b) employing good fertilizer practices and at the proper time to maintain healthy, vigorous growth, which prevents invasion; (c) careful watering to promote deep root systems which result in sturdier turf; (d) promoting good drainage and aeration; (e) using lead arsenate at intervals to discourage the growth of annual bluegrass.

Rough-Stalk Bluegrass

(*Poa trivialis*)

It does not make as solid a turf as Kentucky bluegrass in a sunny location but thrives better than it in shady places. The foliage is a shiny light green.

Redtop

(*Agrostis palustris*)

This is often used in lawn mixtures with Kentucky bluegrass as it grows rapidly the first year. Seeded alone, it forms a rather coarse, open sod which becomes coarser with age, but it is finer than ryegrass. It spreads by rhizomes. It is adapted to a wide range of soil and climatic conditions, including moist locations, and exhibits some resistance to drought. It normally lives only 2 or 3 years when mowed, and it gradually gives way to Kentucky bluegrass when sown in mixture with that species.

Colonial Bent

(*Agrostis tenuis*)

It is also called Brown Top, Rhode Island bent, Prince Edward Island bent, Astoria bent, and New Zealand bent. It is suited to the production of fine quality lawns and produces a splendid turf for bowling and putting greens.

For lawns it may be sown alone or in mixtures. Like Kentucky bluegrass, it spreads chiefly by underground stalks. Velvet and creeping bents spread by aboveground creeping stems or stolons. Colonial bent does not spread so rapidly or extensively nor form as matted or compact a sod as the creeping bents and does not heal injuries or fill in thin stands as quickly. It is less exacting in its requirements than are the true creeping bents. It is more susceptible to disease, such as brown patch, than are other lawn grasses or bents.

Creeping Bent

(*Agrostis maritima*)

The creeping bents form a very dense, fine-leaved turf and are particularly adapted for putting and bowling greens. There are numerous strains. One group is always propagated vegetatively, (var. stolonifera). The stolons are cut into short lengths, distributed uniformly over the area, and covered lightly with soil. The second group of creeping bents is propagated by seed and is frequently termed "seaside" or "Cocos" bent; its main sources are New Brunswick, Oregon, and New Zealand. The seeded creeping bents do not normally exhibit as great stolon-forming tendencies as the vegetatively propagated strains, and, in fact, contain types which vary from non-creeping to very widely creeping.

Creeping bents are more susceptible to disease than are ordinary lawn grasses. Because of their stoloniferous habit and resulting tendency to form a nap or mat they require frequent topdressing and raking in order to prevent matting and graining. Close mowing, careful watering, and frequent use of fertilizer are essential.

Velvet Bent

(*Agrostis canina*)

It produces probably the finest leaves of all bents, is dwarflike in habit, and, where it thrives, makes an excellent putting or bowling surface. However, it is not as hardy as the other bents mentioned, injuries on it heal slowly, and both seed and stolons have been difficult to obtain in quantity.

Chewings Fescue

(*Festuca rubra commutata*)

This is adapted to poorer, drier soils than is Kentucky bluegrass, and is capable of growing in shady locations. It produces a dense, fine, uniform turf. Unless properly established, however, it tends to become bunchy or tufted. It does not spread and so is not capable of filling in patchy stands. Its light green leaf color does not blend well with Kentucky bluegrass. It is the leading grass in the milder parts of British Columbia. When clippings of this species are left on the lawn they become quite conspicuous. The seed is large, compared with bluegrass and redtop.

Creeping Red Fescue

(*Festuca rubra*)

It creeps to some extent by rhizomes and does not tend to form a bunchy turf. Strains vary much in regard to creeping ability and color. Creeping red fescue is useful in mixtures for dry, sandy locations and for shady areas, and some strains can be propagated by stolons.

Sheeps Fescue

(*Festuca ovina*)

Once much used this has now largely been discarded. The invariable result is cuppy lies (depressions in the soil).

Crested Wheatgrass

(*Agropyron cristatum*)

The Fairway strain is a useful lawn grass only in dry and semi-dry areas where facilities for artificial watering are not available. Crested wheatgrass does not possess the characteristics essential to a good lawn grass in most areas.

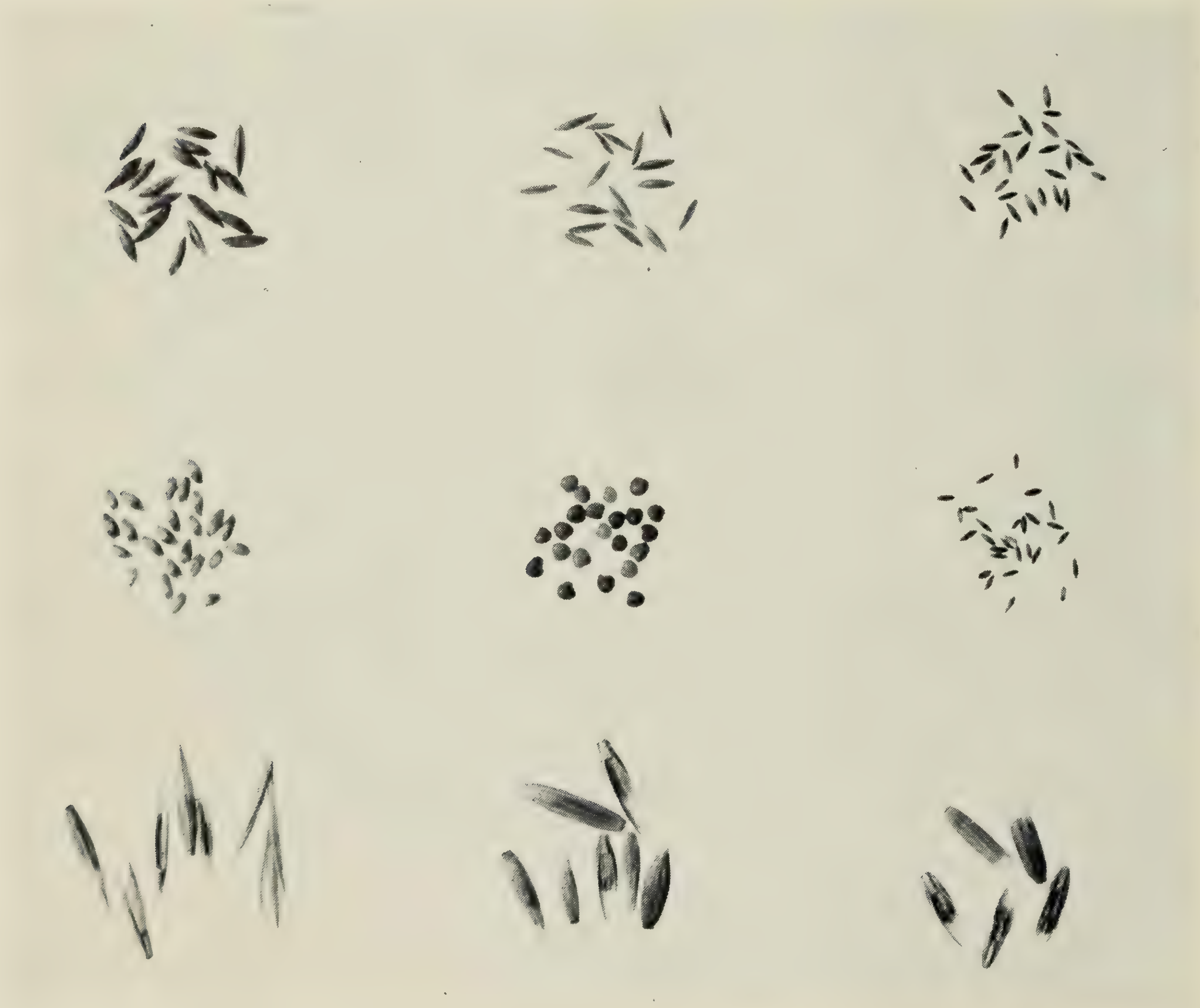

Fig. 2. Relative sizes of grass seeds: Left to right (top)—Kentucky bluegrass, Canada bluegrass, redtop; (centre)—timothy, white Dutch clover, bent; (bottom)—creeping red fescue, English ryegrass, Italian ryegrass.

Perennial Ryegrass

(*Lolium perenne*)

This short-lived perennial, including the Scotch, English, and Italian types, is frequently included in lawn-seed mixtures where a very quick growth is desired. It is not hardy in northern areas, however, and so is not recommended for use in permanent grass mixtures there. It is coarse in leaf and stem, starts rapidly, and produces early effect as well as covering quickly ground that otherwise might support weeds. The use of this grass coarsens the lawn the first year, but it is useful where quick effect is more desirable than fine appearance. Because of its difference in color from Kentucky bluegrass and bents it does not give a pleasing appearance to a lawn.

White Clover

(*Trifolium repens*)

Many regard white clover as a weed; others consider it a desirable lawn species. It becomes established quite rapidly and forms a dense sod which provides considerable competition against encroaching weeds. Unwatered lawns containing white clover usually stay green longer during warm, dry weather than do pure-grass stands. Grass, growing in association with white clover, benefits from the nitrogen fixed by the bacteria which form the nodules on clover roots. On the other hand, white clover frequently winterkills leaving thin or bare areas in the lawn. It frequently grows in patches of varying size, thus giving the lawn an uneven appearance. Most persons object to the white flowers which the clover produces. Clover leaves will stain white shoes.

Seed Mixtures

Only the right kinds of grasses and the very best seed obtainable should be sown. The use of cheap lawn seed mixtures is poor economy since such mixtures usually are low in germination, contain weed seeds, chaff and other foreign material, and may consist in part of poorly adapted species.

There is often considerable variation in seeding recommendations. This is because the seeds of grasses vary in size and weight, and also because of varying climatic and soil conditions.

Grasses vary in habit of growth and in adaptability. Comparatively few grasses are suitable for establishing a good lawn. None of them alone, with the exception of bentgrass which is used for specialized purposes, is suitable for the average lawn. Consequently mixtures of suitable grasses, each with a definite purpose, are used. By adjusting the proportion of the various suitable grasess mixtures may be prepared for different locations. Kentucky bluegrass forms the basis of most lawns because it is permanent and grows under a wide range of conditions. It is relatively slow in becoming established and therefore other quick growing grasses are used in combination with it, e.g. ryegrasses or redtop are frequently mixed with it to provide a quick cover and to fill the ground with roots.

On poor, sandy, or acid soils, or in shady places, Kentucky bluegrass may not thrive as well as certain other grasses. On such soils a considerable proportion of fescues are included in the mixtures. Bentgrasses are more exacting in their requirements than most grasses but when used in small percentages in mixtures they add quality and permanency to the turf. White clover is sometimes included in small percentages for its ability to withstand wear and drought.

The following table indicates how the more common grasses may be combined in mixtures to suit various conditions.

PERCENTAGE OF SEED USED

Seed	*Sunny*	*Semi-shade*	*Remarks*
Kentucky bluegrass	70	40	Permanent type grass; basis of most mixtures. Adaptable. Good quality turf.
Chewing's fescue	....	40	Withstands some shade, acid, and dry conditions.
Redtop	20	15	Fast growing. Used as nurse grass. Not permanent. Coarse turf.
Colonial bent	5		Provides quality and permanency. More exacting in requirements than most grasses.
Italian ryegrass	5	5	Fast growing. Used as nurse crop and for quick effect.
White clover	....	....	Used in small percentages only, e.g., up to 5 percent. Becomes established quickly. Forms dense sod. Drought resistant.

SEEDING

Time of Seeding

The best time to seed lawns depends largely on local climatic conditions, and on the rainfall or availability of water.

Late summer and early fall are seasons when nature sows her grass; it is also the safest time to start a lawn. At this time heat is not intense, there is less weed growth, and the cooler weather encourages good rooting. Seeding should be done early enough to give the grass a good start before freeze-up. A fall-seeded lawn gets away to an early start in the spring and thus can withstand summer heat and drought and compete with summer weeds.

If late summer seeding is impossible, seeding may be postponed until very late fall or early spring. Late fall seeding can be made as temperatures are low enough to prevent germination of the seed until the following spring. This may only be carried out on areas which are not subject to washing and erosion during winter and early spring.

Spring seeding should be done as soon as the soil is in a workable condition. If, however, the seed is sown when the soil is too cold and damp, slow, irregular germination may result. If practicable, it is better to wait until the weed seeds germinate, work the land to kill them, and then sow the grass seed.

Midsummer seedings are unwise, but they can be done successfully if facilities are available to keep the seeded areas well supplied with moisture.

Rate of Seeding

It is poor economy after all the work has been done to skimp on seed, for too light sowing results in a thin "patchy" stand thus offering no competition to weed growth. A thick stand in the early days of a new lawn discourages weed growth.

A common seeding recommendation is 3 to 5 pounds to 1,000 square feet where Kentucky bluegrass forms a high percentage of the mixture. Only seed of high germinating quality should be sown. For small areas the rate of seeding can be increased slightly. For large areas 100 to 150 pounds per acre is a good general rate of application. This variation will be governed by the prevailing conditions.

One pound of a good lawn seed mixture contains 2 to 2½ million seeds. When 3 to 5 pounds are seeded on 1,000 square feet, such a mixture supplies 6,000 to 12,000 seeds per square foot. This is by no means too many, as at least 30 to 40 seedlings are wanted per square inch, and casualties may be high, with too deep coverage, disease, and weak seeds taking their toll. Some grass species contain as many as 8 million seeds per pound, but their seeds are very small. On the other hand, fescue seed is larger than that of bluegrass and requires at least half as much more seed by comparable seeding methods.

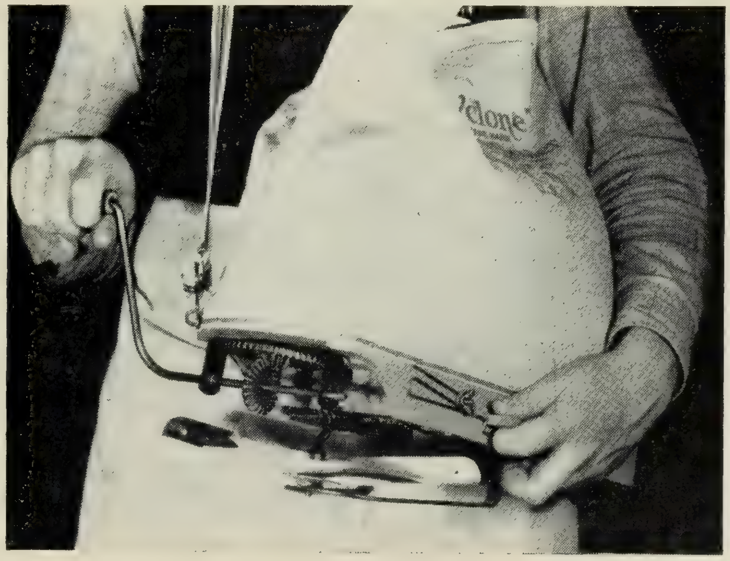

Fig. 3. The cyclone type of seeder enables seeding to be done more rapidly than by hand. When this seeder is used, sowing the outside strip by hand may be necessary to avoid distributing some of the seed to adjacent flower beds or gardens.

Method of Seeding

Small areas are usually seeded by hand. Seed should be distributed evenly, but this is not possible during windy weather. Calmness is more likely to prevail in the early morning or late afternoon. It is well to divide the seed and sow half in one direction and rake it and then sow the other half at right angles to it. Again, strips about 4 to 5 feet wide may be sown at a time.

On larger areas, a wheelbarrow or whirlwind seeder can be used. The low fertilizer spreader on wheels with adjustable slide openings is ideal for sowing seed, as none is spread over the edge into flower beds, and a very even distribution is made close to the ground, thus being economical as well. Some seeders do not sow fescues any too well, so this ingredient perhaps is best sown, separately, by hand.

Immediately after seeding, the soil is raked lightly to cover the seed to a depth of ⅛ to ¼ inch. Putting the seed into channels or islands is avoided by raking in only one direction instead of with a back and forward movement. A light dressing of screened topsoil may also be used to cover the seed instead of raking. Covering seed on large areas is best accomplished by means of a cultipacker, weeder, brush drag, or spike drag.

After the seed is covered the lawn should be rolled to firm the soil around the seed and thus encourage rapid, uniform germination. The roller must be kept dry so that it will not pick up seed and there should be, in fact, three distinct rollings: (a) immediately after sowing; (b) after germination, to press the heaved ground down and firm the roots; and (c) after the first cutting. Rolling is a useful means of pressing stolons of newly planted bents into the soil.

The new seeding should be kept moist but not flooded until the seedlings are well established. When watering, a very fine spray should be used so that the seed is not washed out of the soil.

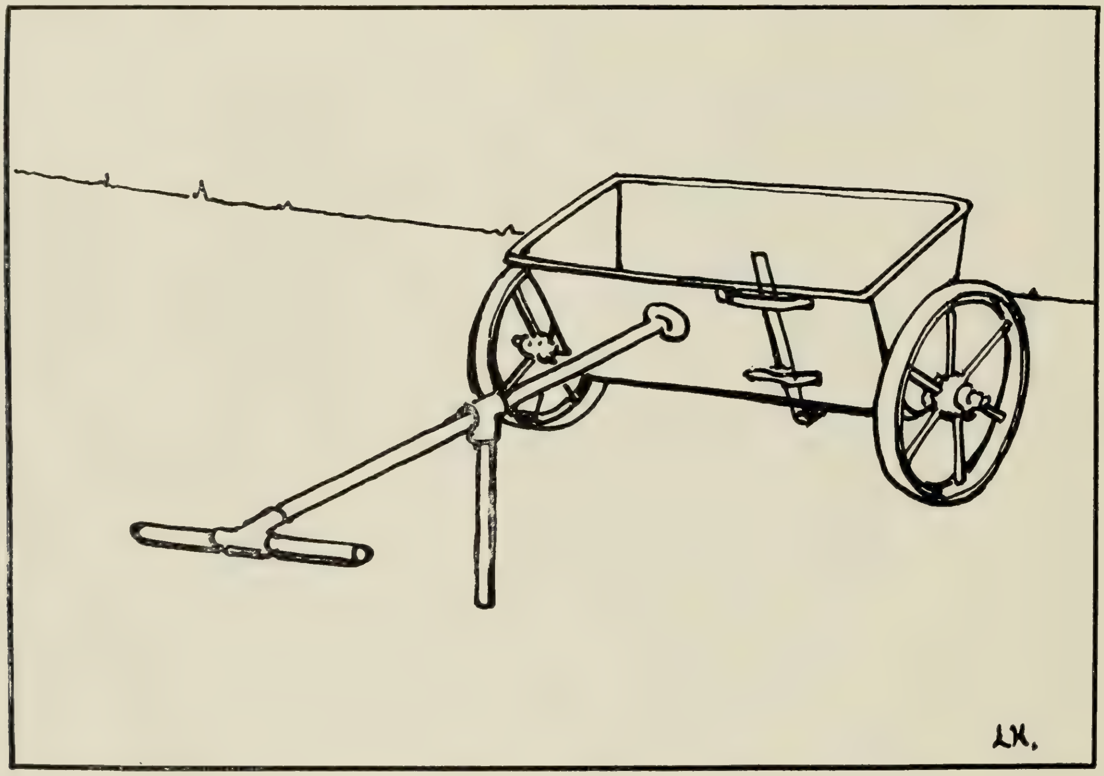

Fig. 4. The low fertilizer spreader on wheels with adjustable slide openings is ideal for sowing seed, as none is spread over the edge into flower beds, and a very even distribution is made close to the ground.

Applying a Mulch after Seeding

The use of a mulch may be a very significant factor in starting a lawn successfully under unfavourable conditions. In this case, it is applied at once after seeding. As good a mulch as any is ⅛ inch of ground sphagnum peat. Peat blows readily. It is best to wet it 24 to 48 hours before seeding and apply damp. Straw in a very thin layer (one straw thick) is good. It is more easily applied if cut. Lawn clippings are good, if carefully and thinly applied. The area should be rolled as soon as the mulch is applied, lightly if the soil is moist, heavily if somewhat dry. Then keep the surface moist until the seedlings are established. (*See* also, later, Establishing Grass on Terraces or Slopes).

SODDING

Sodding is desirable and preferable to seeding in these cases: (a) when one needs to establish a turf in a short time; (b) for terraces or steep slopes subject to washing; (c) on thin or bare spots where hard and frequent usage makes successful seedings difficult. The chief disadvantages of sodding are: (a) it is expensive; (b) it is often difficult to obtain high-quality, weed-free turf. On level ground, probably the only time that a sodded lawn looks better than a seeded one is for the first 2 weeks.

The soil is prepared for sodding in the same manner as for seeding. Sod placed on hard, poorly-drained, infertile soils is foredoomed to failure. Sod will not succeed any better than seedlings in shady places.

All sods should be cut to a uniform thickness, usually about 1½ inches. The sods must hold together during lifting, transportation, and laying. Sod may be purchased from sod supply companies, or cut by means of a sod lifter, or sod plough.

Before sodding an application of superphosphate should be given where the sod is to be placed to encourage root growth. When the sods are in place a complete fertilizer of high nitrogen content should be applied.

The sods are laid so that they fit together perfectly and are not crowded or stretched. Since the sod is cut into uniform strips, when sodding a sloping area like a terrace the strips are laid horizontally and the joints staggered. This method results in least washing at the joints. On a slope the sod is laid by starting at the bottom and working upwards. On a flat area the strip farthest from the source of supply is laid first and the work proceeds backwards. The sods are usually slightly thinner at each corner, and so if four corners are laid together regular depressions occur. One should avoid this when laying sod by placing enough topsoil under the corners to bring them to a level grade.

Before sod is laid, the soil bed should be moist as it is difficult to penetrate dry sods with sufficient water, and root action will start quicker on a moist bed. After it has been laid the sod is watered thoroughly and then tamped carefully or rolled with a medium-weight roller. Sod thus laid sends roots into a fertile soil in 3 or 4 days and, under favorable conditions, is well established in 2 weeks.

Sodding may be done from spring to fall providing moisture is available; spring is probably the best time as new grass roots are then being produced freely. Irrespective of the season the sod must be soaked thoroughly after it is laid to ensure a sufficient supply of moisture at the roots.

Establishing Grass on Terraces or Slopes

Since exposed slopes are susceptible to heat, drought, and water runoff, special attention should be given these areas to make conditions as favorable as possible. The top and bottom of the slope should be rounded so that the mower will not scalp the turf at the top or leave the grass too long at the bottom. The safest method of establishing turf on steep slopes is sodding.

Seeding may be practised on more gradual slopes if erosion is prevented.

One plan is to stretch, and peg down at intervals, very thin cheesecloth over the area after the seed is sown, covered, and rolled. The seedlings grow through the cheesecloth and later, after the turf is established, the material decomposes. The watering of seedlings on slopes is very important as such locations dry out more quickly than do level areas. The water is applied as a fine mist to avoid washing.

Temporary Lawns

A temporary (one season) lawn is sometimes required, e.g., when construction of the lawn area is not completed soon enough in the spring for the establishment of permanent species before fall but a grass cover is desired during the intervening months. In such cases a temporary sward may be obtained by seeding ryegrass at the rate of 7 to 8 pounds, or redtop 3 or 4 pounds, per 1,000 square feet. The seed of ryegrass is relatively large and so is covered ¼ to ½ inch deep. The grass may be mowed 2 inches high throughout the summer. It is turned under in late summer and the soil then worked into condition and otherwise prepared for seeding the permanent species.

CARE OF ESTABLISHED LAWNS

Fertilizer

Lawns usually will benefit from two applications of a "complete" fertilizer each year, one in early spring just before active growth begins and one in late summer or early fall. Fertilizer containing 10 percent nitrogen, 6 to 12 percent phosphoric acid, and 4 percent potash is good for average conditions, at the rate of 10 to 15 pounds per 1,000 square feet per application. It is desirable that complete fertilizers for lawn use contain 25 percent of the nitrogen in organic form.

It is often desirable to apply small amounts of quickly available nitrogen once or twice during the growing season. Nitrogen increases the green colour but the effect is temporary and ordinarily does not last through the season. Sulphate of ammonia or nitrate of soda, 2 or 3 pounds per 1,000 square feet, is highly effective. A mixture of equal parts of these two fertilizers will not change the existing soil reaction. The more nitrogen applied the more frequently will mowing need to be done. It is important that the fertilizer be spread evenly and that all lumps be finely pulverized. If a machine spreader is used care should be taken to avoid overlapping or unfertilized strips. During the growing season the fertilizer must be watered in thoroughly immediately after application. At the time the fertilizer is applied, the grass should be dry, to avoid burning. There is little danger of burning when fertilizer is applied in early spring before the grass turns green. Nitrogen fertilizer can usually be applied safely in liquid form.

Fig. 5. A trim setting to an urban home.

Manure

Well-rotted manure, applied in autumn, is good for the lawn, but is not available to most lawn owners except at high prices and it is odorous. It should be well rotted since fresh or partially decayed manure contains many weed seeds. It should be pulverized before application so as to avoid large lumps on the grass. The use of manure in this manner reduces the amount of chemical fertilizer required, but may not supply all the "plant food" necessary.

Topdressing

Topdressing serves to level small depressions, provides a light mulch for the grass roots and basal shoots, and adds some "plant food". Repeated light treatments at frequent intervals give better results than do heavier ones at long intervals. At no time should a depth of more than ¼ inch be applied, and that rate is used only in the fall or early spring. The material is spread uniformly over the turf and raked carefully into the grass or worked down into the sod and low spots by dragging with a flexible steel mat.

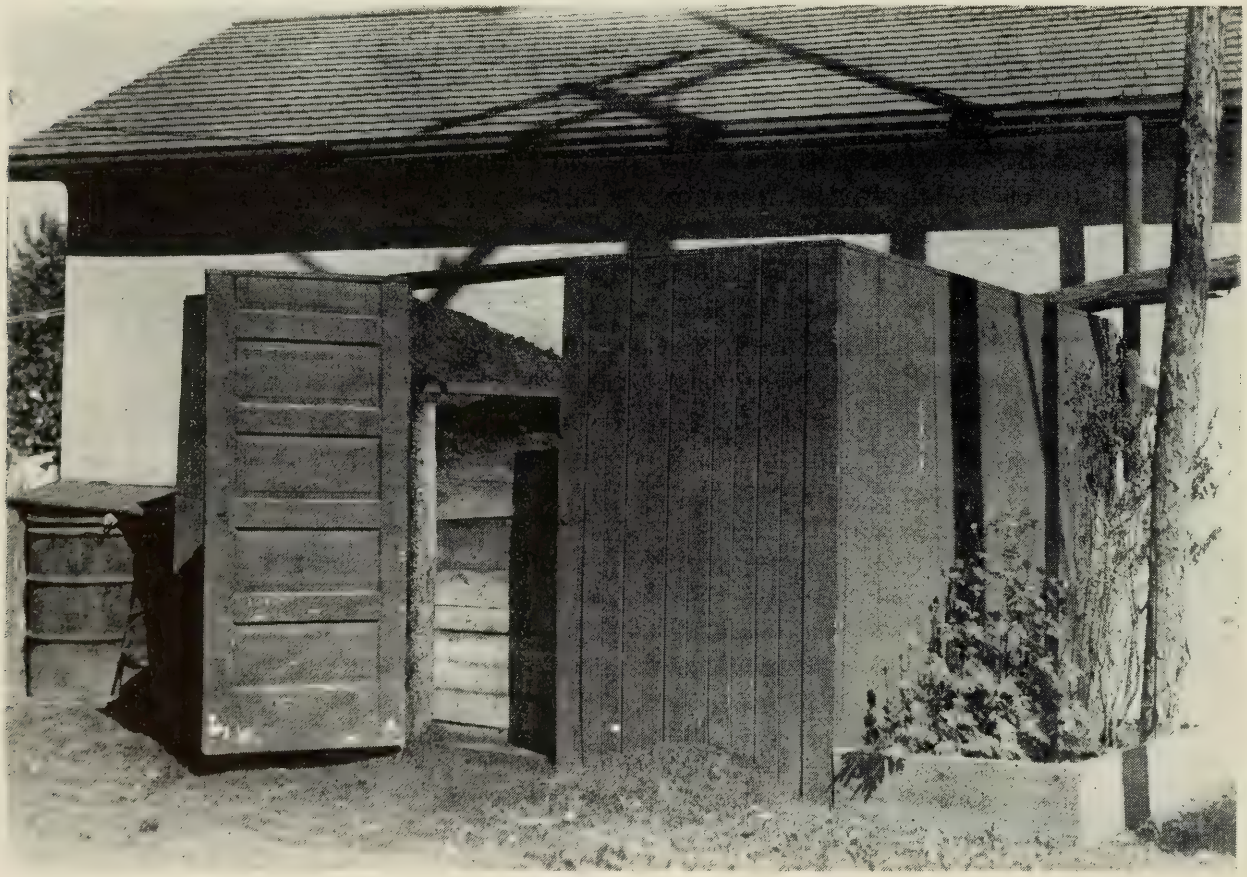

Fig. 6. Topdressing is important in lawn maintenance. This home owner has solved the problem of maintaining a supply of topdressing material by constructing a bin beside his garage.

Suitable topdressing material is prepared by composting manure or other organic material with topsoil or sods. A compost pile may be made by placing alternate 6–to 12–inch layers of soil or sods and manure, or peat, in a pile to a height of 6 to 7 feet.

Compost which has been passed through ½ inch mesh screen makes good topdressing material. If this is not available screened topsoil will be suitable.

Dressing with pure materials such as sand, clay, or peat may cause a layering condition which interferes with the upward and downward movement of moisture and may be injurious to the turf.

Spring Raking

Spring raking should be done very lightly, removing only dead leaves and twigs. It is better to use a leaf broom or wooden rake than a steel rake. One should not attempt to rake all the dead grass out of the lawn. It will soon rot and disappear, adding its bit to the humus in the soil.

Mowing Lawns

Many persons think that it benefits grass to mow it. But the chief reason that grass is mowed is to improve its appearance. The food of grass is produced aboveground, in the leaves through action of sunlight; the more leaf, the more food, the more roots and the stronger the plants. The depth and strength of the roots of grass are almost exactly proportional to its top-growth.

The mower must be sharp so that the seedlings are not pulled out by the roots. A dull mower crushes and bruises the cut tips instead of clipping them cleanly, and may be responsible for the grayish or brownish colour of otherwise healthy lawns. Usually, the mowing machine gets a lot of abuse, but anyone who has cut lawns with a first-class machine in good condition and one of those rusty specimens that are found all too often, will appreciate the difference in finish made by the former. Oiling is very necessary for smooth operation and the difference between high grade, light machine oil and any available oil can be readily noted. If a good lawn is wanted then it is important to obtain a good lawn-mower and keep it that way, for it is in the maintenance of the lawn that one's pride should be.

New seedings should be mowed when the grass is about 2½ inches high, at which time they are clipped lightly. New grass need not be cut until it has reached a length that will not stand upright. It is usually necessary to cut a fall-seeded lawn before winter but where seeding has been late and where the growth is not vigorous the grass is better left uncut. The soil must be sufficiently dry and firm to support the mower when cutting new seedlings since the turf is easily injured at that time.

Established bluegrass lawns should seldom be cut shorter than 1 inch. In fact, grasses of the mature lawn often are seriously injured when clipped to less than 1½ inches. A height of 1½ to 2 inches is preferred on large lawns. If a lawn is free of weeds, its attractiveness suffers little, if any, from high mowing. "Cutting high" does not mean to let the grass get tall before cutting it. The grass should be cut often enough so that not over 1 inch of growth is cut at a time. When grass is cut after being allowed to grow too tall, the lower part will be bleached and unsightly. This sort of grass is slow to recover and green up. Long-continued, excessive close cutting is responsible for much of the difficulty experienced on many lawns. Symptoms of overcutting are a thinning of the turf, weeds, and lack of resistance to drought and disease. Close cutting restricts the natural development of the root system. The closer the mowing the more attention must be given to fertilizer and watering and the less competition the grass can make for encroaching weeds.

Extremely early mowing in spring, like too close cutting, is very hard on the grass. It is at this season that grasses renew their root systems, and early cutting restricts this. The first mowing in the spring is best made when the grass is 2½ to 3 inches long. The lawn may be mowed as often as desired thereafter, provided it is not mowed closer than 1½ inches. Mowing is continued until cold fall weather prevents further growth.

Light mowing will help to maintain grass in areas which are shaded enough to make grass growing a problem. Mowing only a few times a season will permit grass to live on many areas where it would die if cut with the rest of the lawn. Surely long grass looks better than no grass!

The ordinary 4- or 5-blade mower is not efficient for cutting bentgrass, and so a special mower is required. The bentgrasses and creeping fescues can be cut shorter than bluegrass because they have a heavier growth of basal leaves than bluegrass.

Return of Clippings

The first cutting after seeding should be left on the ground as a mulch. It rots quickly and at the same time keeps the ground moist and the young grass protected.

Mowing should be frequent, perhaps once or twice a week under normal conditions. When heavy clippings remain they smother the grass and otherwise spoil the appearance of the lawn. If they are removed, on the other hand, the results are equally damaging, because of the sudden exposure of the young shoots to the sun.

If the lawn is mown often enough so that a dense mat of clippings does not remain on the turf at any time it is not necessary to remove them unless they contain weed seeds. If the lawn is weedy a grass-catcher should be used and the clippings removed when these weeds are producing seeds. This does not control the distribution of weed seeds but it helps reduce reinfestation. If mowing is neglected and a heavy growth results, e.g., in rainy weather, the clippings should be removed. If the lawn is shady, the clippings, if allowed to remain, may cause a moldy condition in damp weather, and generally should be removed.

Lawns which are composed of bentgrass require removal of the clippings This is especially true where the straight run of a ball would be affected on greens. The turf cultivator is especially valuable for removing the nap from bent greens. There are special metal rakes, on wheels, which are exceedingly handy for removing the grain from creeping bent. They prevent the bent from running and rake up the matted grass so the mower can cut it properly. Also, they are handy for spreading worm casts and working in topdressing.

Rolling

The purposes of rolling established lawns are these:

1. To firm the ground around the grass roots (after freezing and thawing of winter have heaved the soil and left the surface loose and uneven) and thus avoid drying out of the plants.

2. To level the surface and thus facilitate uniform mowing in contrast to "scalping" which is unavoidable on an uneven surface.

3. Rolling promotes, to some extent, the bringing up of moisture to the young roots by capillary action, thus, in effect, watering them more effectively than from above. (The effect from a spike-tooth roller is indicated later).

The roller should be just heavy enough to accomplish these purposes. With a water-filled roller the weight can be adjusted to suit conditions. Such a roller, 1½ feet in diameter and 2 feet long, outside measurements, holds approximately 25 gallons and when filled with water weighs about 275 pounds. A roller of this kind filled to capacity gives good results on sandy soil, but on heavier types the quantity of water should be reduced, e.g., to just enough to firm the heaved turf back into the soil. An excessively heavy roller makes the surface hard and impervious to water, as will repeated rollings during the growing season, especially on heavy soils. On newly-seeded lawns it is advisable to wear soft running-shoes when rolling.

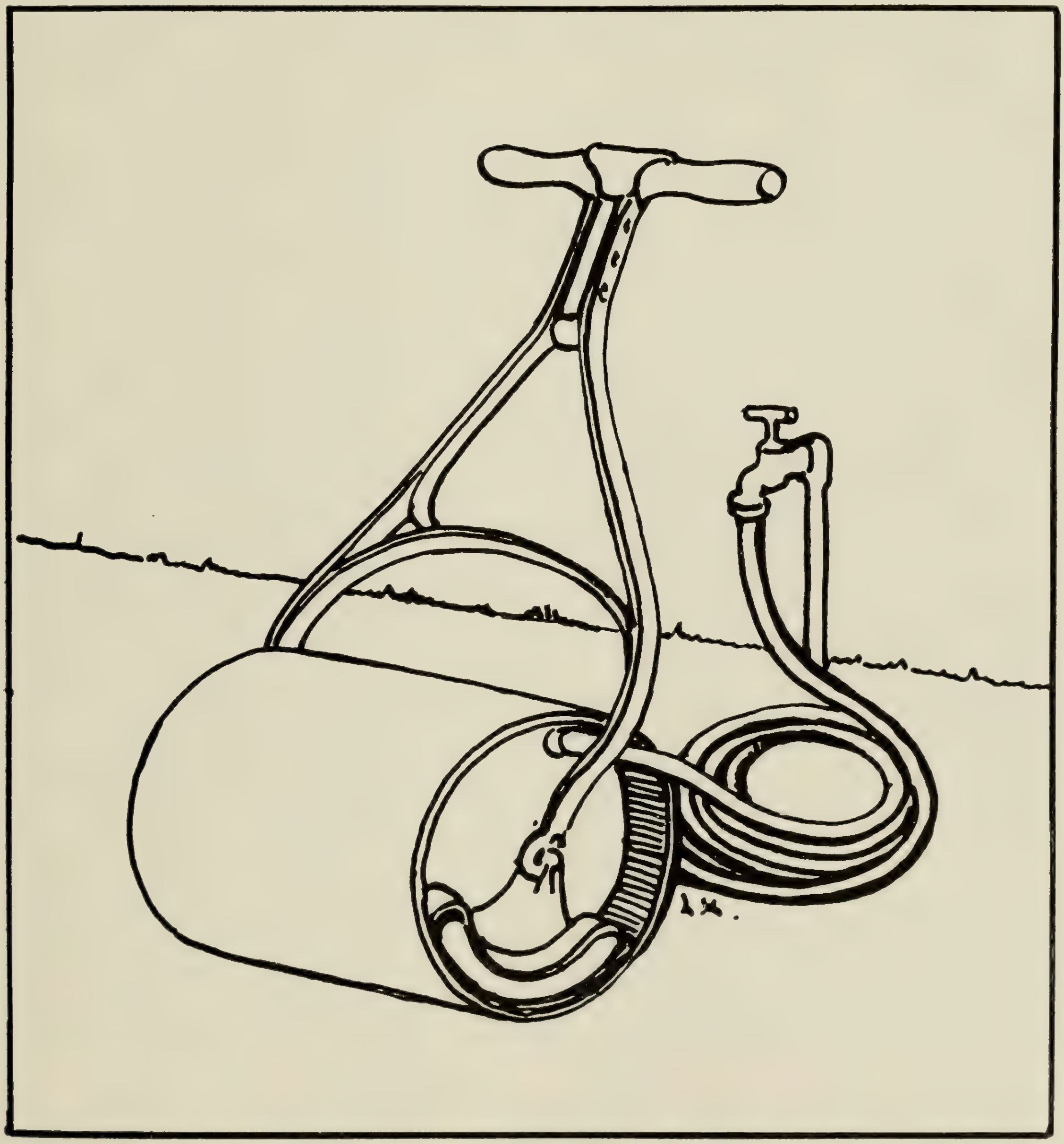

Fig. 7. The weight of a water-filled roller may be adjusted to suit various soil types and conditions.

When to roll most effectively depends on the condition of the soil. If the soil is too dry the roller lacks effect and if it is too wet it causes packing and loss of desirable soil texture. One rolling, early in spring, usually suffices for the year. But, frequent rolling of golf and putting greens is essential.

Topdressing is a more effective and desirable method than rolling for smoothing small depressions in the lawn.

Watering

The soil must be moist until the new growth is well started. It is preferable to give a heavy soaking, without washing away the seeds, rather than to give several light waterings each day. The latter tends to discourage deep rooting. Grass seeds germinate over a period of almost a month, so an extended period of watering is required. If the surface soil is allowed to dry out many of the young seedlings will die. Mature grasses tolerate considerable heat and drought without permanent injury. If not watered during midsummer they appear brown and dead but revive quickly with the cool moist weather of early fall. Whether or not watering is practised depends on the degree of desire to maintain a green lawn throughout the summer.

The established turf need not receive water until it shows signs of needing it. Then, the soil should be moistened thoroughly for at least 4 inches to encourage the development of a deep, healthy root system capable of utilizing fully the soil fertility. Frequent, light sprinklings are not suitable since they encourage the growth of shallow-rooted weeds and tend to restrict the roots of the grass to the upper layers of soil, thus reducing their feeding range and making the turf even more susceptible to drought and heat injury. Sprinkling with hose in hand may cool off the owner, but may not help the lawn much.

Slopes and terrace banks require special attention in watering, since they dry out very quickly and the amount of runoff is great. Water should be applied very slowly to such areas and permitted to soak in thoroughly.

The lawn may be watered at any time of the day that is convenient. Early morning or early evening watering permits more effective use of the water, since evaporation rates are slower. Watering when the sun is shining and during the hot part of the day does not injure the grass, unless the contour or soil drainage is unsatisfactory and the water does not soak into the ground or drain away. In the case of greens where brown patch disease is present, during hot, muggy weather in midsummer it is good practice to apply water only in the morning so that the turf will not go into the night in a wet condition.

Where water is not available, one should time the seeding date to take best advantage of rainfall. Also, it may be necessary to resort to species of grass that are somewhat inferior in appearance but which are comparatively high in drought resistance. Before constructing the lawn the soil should be plentifully supplied with humus to increase the waterholding capacity.

A variety of artificial sprinkling systems are available, e.g., border mist, peacock sprinkler, estate sprinkler, and also with the sprinkling heads concealed in the lawn and fed by a system of underground piping. The sprinkling system should receive attention before winter to avoid expensive pipe bursts.

Spiking

Regular spiking is not necessary on most lawns. But, occasionally small areas on old lawns may fail to grow healthy grass, not because of disease or insect injury, but because of a hard, dry soil which is very impervious to water and fertilizer. On a small area, this condition can be corrected by deep spiking with a special tubular fork. Deep forking with steel forks, either potato forks or manure forks, can be used. These forks should be pushed into the ground to a depth of 6 to 8 inches and wiggled back and forth in order to open up the holes. This method works well and quickly, but it does not give fully satisfactory results as the soil is not removed from the holes, but is only compressed and this tends to seal the soil around the holes. On a large scale, a rotary spike disc, spiker and perforator, a turf cultivator, or a mechanically operated drill, will do the work quickly. Opening up and aerating the soil by spiking enables the topdressing or fertilizer to enter at a sufficient depth to improve the soil structure where the grass roots must develop. Actually, after the surface of the lawn has been perforated with a fork or any other device, it is not necessary to attempt to fill these holes with topdressing. It might be far more beneficial in many cases to leave the holes open to permit water penetration and aeration.

WEED CONTROL*

When grass thins out and weeds begin to infest the lawn, there is reason to suspect either neglect or faulty maintenance practice. The first step in weed eradication is to determine the cause of infestation. If it is due to low fertility, strongly acid soil, close mowing or other management problems, these should be corrected along with the weed treatment. Eliminating weeds without removing the basic cause gives only temporary success, and the work will soon need to be repeated.

It is useless to try to eradicate weeds where the grass is making so feeble a growth that it does not occupy the ground. Many persons say, "I'll get rid of the weeds first and then fertilize the grass." If there is grass enough in the lawn to be worth saving, the fertilizing and weed eradication must proceed together. Fertilize enough to make a good growth of grass possible, and at the same time take such steps as may be necessary to eliminate the weeds.

When an area is occupied mostly by weeds, it often happens that the best way to get rid of them is to make a new lawn in early fall, working the ground for a month or two with a hoe or other available method and digging up the larger perennial weeds, until the weeds are eliminated.

Lawn weeds may be divided into (a) annuals, which must produce seeds in order to reproduce themselves, and (b) perennials, which grow from year to year from the same roots. The logical way to control annual weeds is to prevent them from distributing seed, either by removing or destroying the plant itself or by removing the seedheads before they set seed. With perennial weeds, the entire plant must be removed from the soil or otherwise destroyed. Many perennial lawn weeds are difficult to eradicate because they possess underground rootstocks in which they store reserve food materials and from which new plants grow even though the top growth is killed.

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*The Department of Botany, O.A.C., is conducting extensive work on weed control and may be consulted for further information on the subject, including the identification of weeds. This is likewise the case with the Department of Entomology for insects and their control, and with the Department of Soils for soil analyses and fertilizers.

Dandelion

It has a deep taproot which, unlike the roots of most plants, is capable of producing new tops from any portion of it.

Cutting the dandelion with a knife results in a circle of new sprouts from the root, even though it is cut far below the crown. The root sends up new tops after cutting, but by repeated cutting deep below ground the root reserves eventually are exhausted and the plant killed. But, the method is practicable only on small lawns with a few dandelions. Cutting the dandelions at least temporarily improves the appearance of the lawn by removing the broad leaves. Unsightly holes may be left and weed seeds be deposited there.

Spot treatment with various chemicals such as acids, gasoline, and salts to the crowns of dandelions gives variable results. The top may be regenerated from the crowns, thus necessitating frequent treatments. A drop of concentrated acid applied to the crown of the plant with an eye dropper not only kills the crown but also the root. This is only practical on small areas.

The best control for dandelions is spraying with 2, 4-D. (*See* later, 2,4-D as a Weed Killer.)

Plantain

The chief representatives are common broad-leaved plantain and narrow-leaved plantain (also known as buckhorn and ribgrass.) They are chiefly troublesome in poorly-drained areas and on soils of low fertility. New tops are not regenerated from the roots of these plants, as in dandelions, and so one cutting by hand, well below the crown, will kill the parent plant. Weeding operations should be done before the plants set seed. *See* also 2,4-D as a Weed Killer.

Crabgrass

This warm-weather annual, often called "summer grass," germinates in midsummer. It "likes" hot weather as much as bluegrass "dislikes" it, and establishes itself usually, while the bluegrass is more or less dormant. Then when rains come, it makes rapid growth, crowding the bluegrass severely. It runs along the ground, takes root at every joint and sends up new shoots from the rooted joints, so that a single plant may cover 2 or 3 square feet. The seedheads are long, slender, and joined like the fingers of the hand, hence the name "finger grass."

The seedlings are easily recognised in the two-leaf stage by their broad, short, sharply-pointed leaves which are covered with fine hairs. At this stage they can be easily pulled. It is almost impossible to eradicate crabgrass by hand-pulling after it is well established as the stems root at the nodes. If the plants become established it is then necessary to prevent seed setting and distribution in so far as is possible, raking the lawn to lift the seedheads, then mowing, catching the clippings in a grass-catcher and destroying them. The raking and mowing should be repeated several times in opposite directions before the seed is ripe. Distribution of seeds is not prevented by this method but the degree of reinfestation is reduced.

Crabgrass does not tolerate shade, seldom being found in the shade of a building or tree. A dense, moderately long growth of grass helps shade out the seedlings. The mower should cut 1½ to 2 inches high and everything possible should be done to promote a dense, vigorous sward. Light frequent waterings are harmful as the shallow-rooted crabgrass receives the chief benefit.

Chickweed

There are two species which are common lawn weeds, common chickweed, which is an annual, and mouse-ear chickweed, a perennial form. Both are small-leaved, low-growing, creeping plants which root at the nodes and form dense matlike patches. They bear tiny, white, star-shaped flowers and are abundant seed producers. Small plants which have not had time to spread extensively can be pulled by hand. The best control is to use 2,4-D.

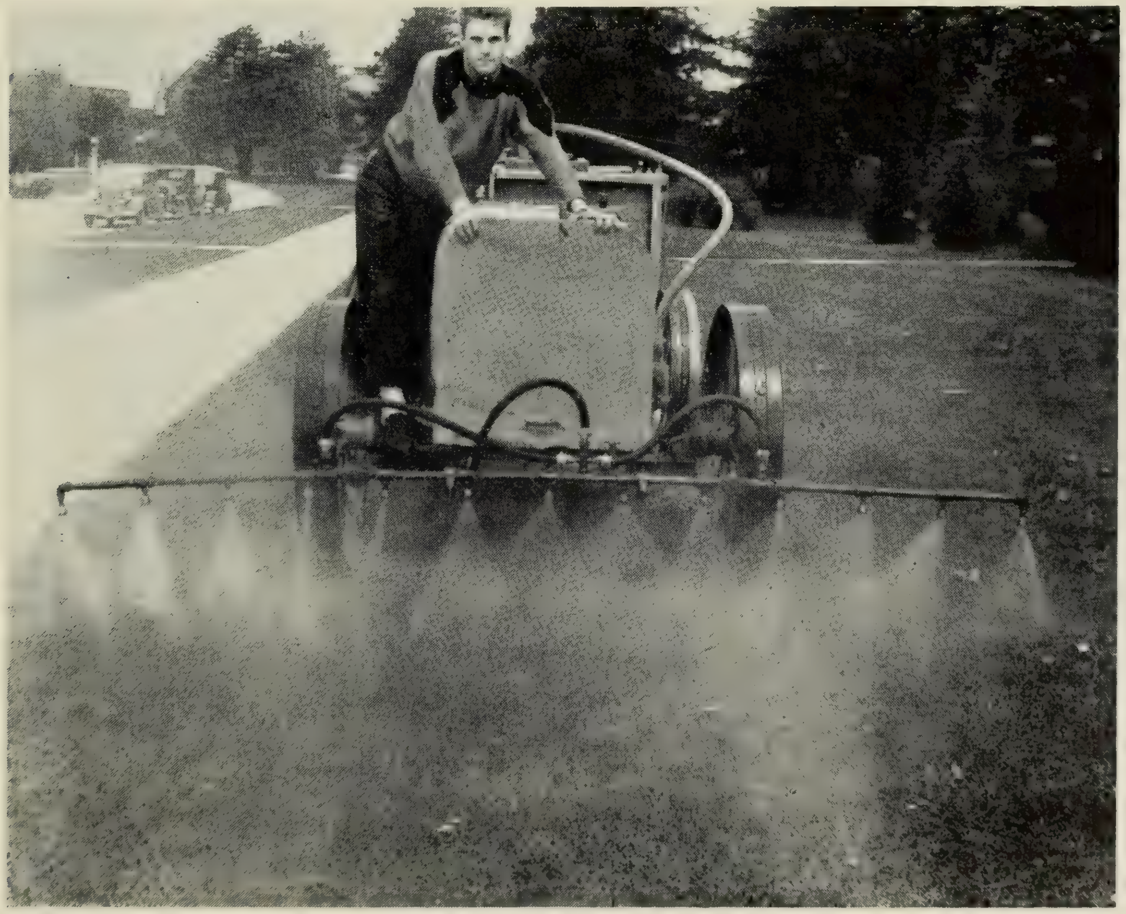

Fig. 8. One useful type of sprayer for treating large lawns with a weed killer.

2,4-D as a Weed Killer

2,4-D (dichlorophenoxyacetic acid) is a hormone or plant growth regulating chemical which when applied in sufficient concentration becomes a selective weed killer and kills many broad-leaved weeds without injuring grass. It it more efficient than most weed killers since it not only kills leaves and stems but also the roots and so prevents regeneration. Some weeds are resistant to 2,4-D but it prevents many of them from setting seed therefore multiplication is checked.

Many commercial preparations of 2,4-D are available. These vary in concentration and should be applied strictly according to the directions of the manufacturer. The concentrations usually vary between 1,000 and 1,500 parts per million. These applied at the rate of one-half gallon, per 100 square feet will give effective control of most weeds on lawns.

2,4-D is fairly cheap and easy to apply. A fine spray completely covering the lawn so that the foliage of the weeds is thoroughly wetted is most effective. A small pressure sprayer with a 2½ to 3 gallon capacity, or a knapsack sprayer, is suitable for applying the spray on small areas, and a pressure tank with boom attachment on larger lawns. Applications with a sprinkling can require much more solution, and are not desirable.

Dry preparations of 2,4-D are also available and in the absence of spraying equipment these provide a convenient method of application. Some preparations are mixed with fertilizers and so it is possible to apply an effective weed-killing and fertilizing treatment in the same operation, which saves both time and labour.

Treatment with 2,4-D is useful as a method of controlling weed seed in manure and soils which are being prepared for topdressing lawns.

Temperatures of 70 to 80°F. are best for spraying with 2,4-D. At cool temperatures results are obtained much more slowly. However, temperatures over 90° are to be avoided. It is desirable to make the application at least 5 hours before any rainfall so that the chemical may be absorbed by the foliage.

Several sprayings can be made without injury to the grass. For the control of most lawn weeds, however, one spraying is usually enough.

Care must be taken in applying 2,4-D since windblown spray will cause injury to garden plants and ornamentals.

Within two or three days after spraying with 2,4-D the leaves and stems of weeds begin to curl and twist in a peculiar maner, and the plants gradually die. Even the roots decompose. The rate of killing depends largely on the temperature at the time of spraying and following the application. Killing is usually most rapid when weeds are in a succulent growing condition.

Various broad-leaved lawn weeds killed by 2,4-D compounds include dandelion, plantains, common ragweed, ground ivy, black medic, shepherd's purse, and yellow wood sorrel. Knotweed is injured so severely it usually fails to produce seed. Chickweed, usually, must be sprayed several times before control is complete. This is because of re-growth from seeds or shallow horizontal roots.

Reinfestation of soil following early applications of 2,4-D is not likely to occur during the first season. Spraying at the usual rate can be done on young grass without serious injury, especially after the first cutting, but spraying with it at the time of seeding is not recommended.

Weeds of the grass family e.g., crabgrass, pigeon grass, and foxtails, are not affected by 2,4-D at any stage.

After 2,4-D applications, bare patches, caused by the death of broad-leaved weeds, are often evident and the area may appear to be "thin" in grass. Therefore seeding, topdressing, fertilizing, and other good maintenance practices are essential. Besides killing the weeds, one should prescribe for a rebirth of the lawn, and consequently reinstate as well as devastate.

The sprayer used to apply 2,4-D should not be used to spray with fungicides or insecticides unless the residue in the equipment is most thoroughly removed, otherwise severe plant damage will result. Household ammonia is of considerable influence in removing 2,4-D residue from equipment. The first step is to fill the tank with hot or cold water (the use of cold water requires more time to complete the job), rinse, and drain. Then fill the tank with water almost to capacity and add household ammonia, 1 part to 100 parts of water. Fill the tank completely with water and agitate. A small portion of this solution should be circulated through the entire system to wash out the lines. The equipment is then let stand for 18 hours when hot water is used, or from 36 to 48 hours when cold water is used. Finally the equipment is drained, and rinsed twice with clear water, circulating the water through the entire system.

Moss

Moss will not compete with grass if cultural conditions are right. The presence of moss does not necessarily indicate a sour or acid soil. The chief causes of moss are low fertility, poor drainage, and too much shade, and the logical method of control is to remove the cause. Areas heavily infested with moss should be spaded and then re-seeded after soil improvement or shade removal has made conditions suitable for grass. Where the infestation is light moss may be raked out with a steel rake.

INSECTS AND OTHER PESTS

Ants

Ant colonies in large hills may be exterminated by punching several holes in a hill and here and there around about 6 inches deep, e.g., with a screwdriver, and pouring in 1 or 2 tablespoonfuls of carbon disulphide with a funnel or oil can, then closing the holes with moist soil and covering the hill with soil or a damp bag. For small hills, a few drops of carbon disulphide may be injected into the opening with an oil can and the grass pressed to fill the hole. This treatment destroys the grass close to the hill. Calcium cyanide can also be used. A small quantity of the powder poured into the entrance of the hill produces a deadly gas when it contacts moist soil. Care must be taken not to spill any carbon disulphide or calcium cyanide on the turf as it will burn the grass. When using carbon disulphide remember that it is inflammable.

Another control for ants is the distribution of poison baits on the hills or at short intervals over the lawn or along the sidewalk. Such baits kill slowly and so they may be transported and stored by the ants and later, when consumed, the entire colony, including the queen, may be destroyed. Sweetened, jellied thalium sulphate or rotenone (e.g., derris) are often quite effective. Thallium sulphate is poisonous to animals.

Moles

Moles may be destroyed by poison, traps, or asphyxiation. Traps are set so as to catch the mole as it travels through the underground runway. Calcium cyanide is placed in the runways at 5-foot intervals, and the openings are afterwards closed but not tramped down. Moles may be asphyxiated with the exhaust gases from an automobile. A garden hose is attached to the end of the exhaust pipe, the other end is inserted in the runway, any openings in the runway are closed, and the motor is run for 20 minutes. The ridge over the runways is pressed down after the moles have been killed.

Beetle Grubs

The beetles lay eggs 1 to 3 inches deep in the soil in summer. The eggs soon hatch into young larvae, which grow to about 1 inch long, and these feed in the upper few inches of soil, consuming the grass roots. When 10 or more grubs occur per square foot of turf, severe damage results. Good control is to apply lead arsenate powder, 10 to 15 pounds per 1,000 square feet of lawn; diluting it with 40 to 50 pounds of good topsoil aids uniform distribution. One treatment normally "grubproofs" the soil for a number of years. This material, though poisonous to humans and animals if taken internally, does not injure the grass.

Earthworm

The "night crawler" is often a pest on close-cut bentgrass turf. It brings up unsightly earth casts but otherwise does not injure the turf in any way. Arsenate of lead applied to control beetle grubs will also eliminate earthworms. Since this poison must be carried deeper into the soil to destroy earthworms than is the case with grubs, it may be necessary to use more of the poison and in repeated applications. Worm casts are rich in "plant food" and their tunnels aerate the soil, and so they are "earth conditioners."

Sod Webworm

In dry seasons, especially on lawns that are green and luxuriant, the larvae sometimes eat the grass leaves and use the digested material along with soil and pieces of grass to build small silk-lined tubes at the soil level of the grass. Spraying 2 pounds of lead arsenate in 20 gallons of water per 1,000 square feet, or dusting with 8 to 10 pounds for a similar area, is effective.

DISEASES

Brown Patch and Dollar Spot

Lawn grasses are seldom harmed seriously by disease outbreaks. *Brown patch* and *dollar spot* are limited to bentgrass lawns. Circular brown areas of grass indicate the presence of these diseases, the former occurring mostly in hot, humid weather of summer and the latter in the cool weather of spring and fall. Both diseases are controlled by a mixture of 2 parts calomel and 1 part bichloride of mercury. Use of 3 ounces of this mixture per 1,000 square feet as a spray or dust gives a good control for short periods. Dilution of the 3 ounces with 10 to 15 gallons water or with 20 to 30 pounds of good topsoil helps assure uniform coverage. Overdoses may burn the grass severely. Organic mercury compounds are effective but must be applied at a higher rate than the calomel and bichloride. *See* also Watering.

Snow Mould

Snow mould occurs frequently on lawns and fairways in northern regions. The fungus becomes active at near-freezing temperatures when there is excessive moisture on the ground because of melting snow or rain. It appears first, usually when the snow is melting, as a thick webby growth of mycelium covering patches of turf which vary in size from a few inches to several feet across. Applying calomel preparations in fall and spring, and breaking up the mycelium on untreated turf in the spring, by brushing with a stiff stable broom, are the control measures.

Winterkilling in Lawns

Winterkilling may take place in lawns which are subjected to low temperatures and which lack adequate snow cover or are exposed to cold, drying winds. Alternating high and low temperatures cause damage. Unsuitable species of grasses commonly suffer. Portions of the turf may be killed as a result of smothering by water and ice lying in depressions. A common type of injury occurs when traffic is permitted on frozen turf. Severe damage may occur if a sheet of ice, such as a skating rink for the children, lies on the turf for a long period, particularly if the soil is not frozen before the ice is formed.

Fig. 9. A vista looking towards the Administration Building at the Ontario Agricultural College. For such scenes the primary setting is a well-kept lawn.

Poor drainage may result in patches of injured turf, because of standing water or because the soil is saturated for long periods with consequent smothering or restriction of the grass root system. If it is impossible to prevent water from collecting in "pools," then bluegrass or fescue may need to be replaced by bentgrass because it will tolerate surplus water. In fact, the bents are sometimes called "water grasses."

Renovation of Poor Turf

Some causes of deterioration of old lawns are these: (a) Poor soil or too thin a layer of good surface soil; (b) poor drainage or settling, resulting in irregular cutting; (c) lack of reseeding; (d) lack of rolling where heaving has occurred; (e) presence of old trees with roots near the surface; (f) too many trees branching low, causing heavy shade; (g) perennial weeds and undermining by pests; (h) too rough and constant hard use; (i) improper maintenance such as infrequent cutting or raking, or general neglect, or too close cutting.

Lawns in a very poor state may need to be reconstructed as previously outlined. Other cases may be remedied by correcting the fertility, by improving the soil condition, and by making certain that sufficient moisture is present. The fertility may be improved by topdressing and the use of fertilizer. Poor soil condition may be remedied by using implements such as a spike roller, turf cutter, and so forth. This facilitates the introduction of topdressing and fertilizer into the turf. If the lawn is so thin that a light seeding is necessary, the topdressing material, if sufficient is applied, will make a suitable seedbed.

Much seed is wasted every spring in reseeding established grass. It is generally useless to reseed unless there are bare areas at least 1 foot square. Grass seedlings have little chance in old sod and the money and time spent in seeding might as well be saved. Bare spots should be sown like a new lawn. The edges of reseeded areas must be clipped regularly. Otherwise the old grass will kill out the new at the border, from 3 to 5 inches out.

Neatness and Finish

There is no other part of the garden that requires such constant attention as the lawn, and unless it receives regular cutting and neat clipping it will cause the whole garden to look shabby no matter how brilliant the flower border may be. But, if a garden picture is framed by a smooth clean lawn which has that suggestive quality of making one want to lie down on it, then much has been accomplished for gardens are judged by appearances and attractiveness, and there is no appeal so invitingly subtle as a well kept, neatly edged, clean lawn.

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TABLE TURNIPS (RUTABAGAS)

by

Staff Members of the Ontario Agricultural College,
Guelph, Ontario

ONTARIO DEPARTMENT of AGRICULTURE

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TABLE TURNIPS
(RUTABAGAS)

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Acknowledgment is tendered Mr. W. F. Strong, Supervising Inspector, Fruit and Vegetable Division, for his many helpful suggestions during the preparation of this bulletin.

GROWING AND HANDLING TABLE TURNIPS

G. P. McRostie and J. Laughland,
Department of Field Husbandry, O.A.C.

The following suggestions are based on tests made at the Ontario Agricultural College and on practices followed by many successful growers in Western Ontario.

The Soil and Its Preparation

1. Use good, clean, fertile, medium loam soil.
2. Cultivate at two or three intervals before seeding to destroy weeds.
3. Use 200 to 400 lbs. of 0-12-6 fertilizer after manure or after clover sod has been plowed down; otherwise use 2-12-6. If manure is used it should be applied the previous year to reduce maggot injury. Broadcast the fertilizer or drill it in before seeding. If the fertilizer is applied by side dressing use about half the amount.
4. Have the soil well worked just before seeding.
5. If ridging is done make the ridges low; 2 to 3 inches high is ample. A ridger is now available to make these low ridges.

The Seed

1. Buy registered seed of Purple Top Varieties. There is none better than Laurentian.
2. Be sure the seed is treated with Semesan or with corrosive sublimate for Black Rot. (See under Diseases.).

Seeding

1. One-half pound of seed per acre is ample.
2. If your seeder will not sow this amount uniformly, roast half the seed. To do this, place the seed for roasting, about one inch deep, in flat pans and roast in the oven for about 2 to 3 hours at 300° F. A very hot oven might burst or char the seed. Place a few of the roasted seeds between wet paper for two days to be sure none can sprout. Mix the roasted seed with the live seed, half and half, by pouring back and forth from one container to another. Sow the mixture at 1 lb. per acre.

OR The turnip seed may be sown through the fertilizer runs of a grain drill. Set the machine to sow 100 lbs. of fertilizer per acre. Leave every fourth spout open. Thoroughly mix one-half pound of seed with every 25 lbs. of fertilizer. If the drill cannot be set to sow this small amount, uniformly, use more fertilizer with the seed. This small amount of fertilizer is used only as a means to obtain uniform distribution of the seed and must not be considered as the fertilizer requirements. Do not mix the seed and fertilizer until just before seeding, otherwise injury to the seed may result.

OR Turnip seed can be mixed with chick grit of approximately the same size as the turnip seed. Mix at the rate of 14 cups of chick grit to 1 cup of turnip seed. Sow with the grain drill set on finest adjustment of wheat size.

Time of Seeding

The main crop is usually sown during the last two weeks in June.

Thinning

Thin when the plants are 1½ to 3 inches high. Thin to 6 to 8 inches apart. It is necessary to use a hoe of not more than a 6-inch cutting edge. Six to eight inch spacing will give the highest yield and smoothest turnips.

Cultivation

Cultivate only for weed control and only to a depth of 1 to 2 inches. In other words merely "skim the surface". Avoid deep cultivation especially after the turnip roots begin to enlarge.

Grading

All turnips are packed and sold under specified grade requirements.

Canada No. 1—2 to 4 in. across (limited market).

Canada No. 1—3½ to 5 in. across, Canada No. 1—4 to 6 in. across (most popular sizes).

Canada No. 1—4 in. and up, across (dehydration and soup only).

Culls include those which are off shape, gouged, bruised or punctured, and also those containing growth cracks, worm injury, water-core, or any of the rot diseases such as Black Rot, Soft Rot, and Skin Rot.

Harvesting

1. There are some implements on the market which aid in harvesting but as yet most turnips are pulled by hand and trimmed with a sharp well-balanced butcher knife.
2. Cut off the tail end of the root 1 to 1½ inches below the butt and rub off any small side roots with the back of the blade. Cut off the top with a single stroke leaving ¼ to ½ in. of neck, but do not cut into the body of the turnip.
3. Pull and trim two rows at a time.

Handling

1. Once turnips are pulled, freezing or sunburning may make them culls.
2. The turnip fork should have knobs of sufficient size on the ends of the tines to prevent puncturing.
3. Bruising of turnips can be prevented by placing bransacks filled with straw under the chute for the first load, and against any sharp edges in the storage bin.
4. Never store culls along with shipping turnips.

WATER-CORE OR BROWN HEART OF TURNIPS AND CONTROL

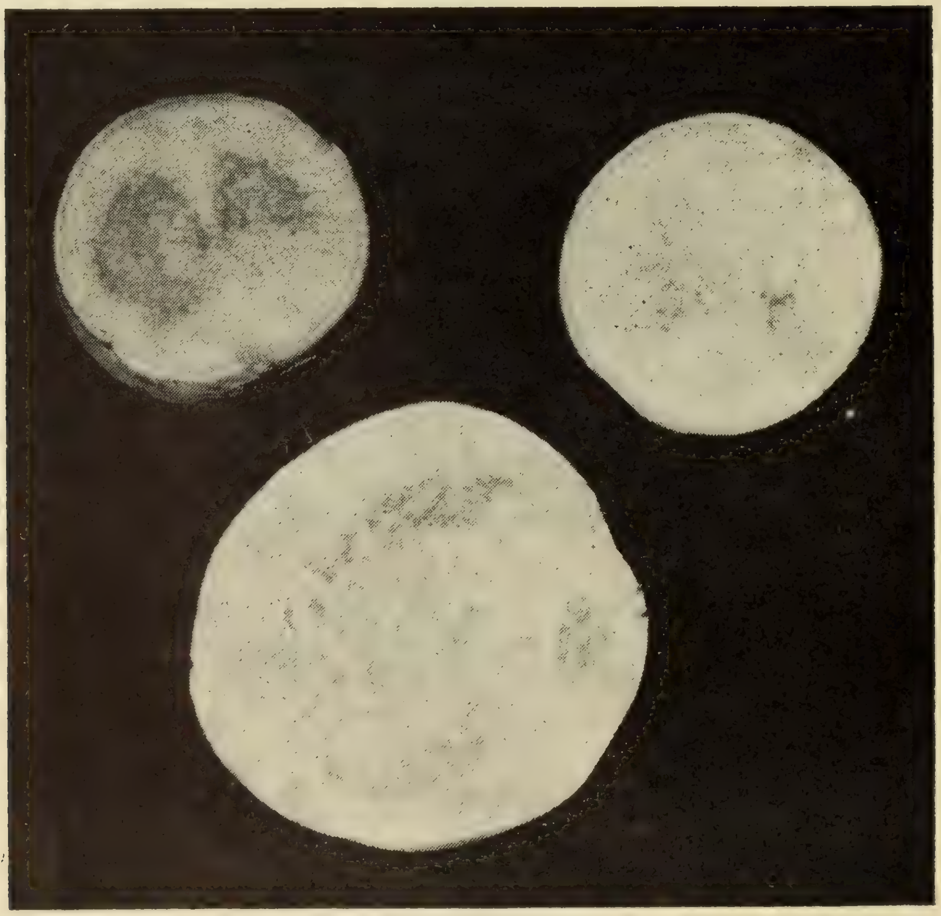
J. D. MacLachlan, Department of Botany, O.A.C.

Description

In the early stages of development the disease appears as water-soaked, but firm, patches in the turnip flesh These areas may increase in size until almost the entire turnip is included. Severely diseased turnips may become brownish and punky inside, a condition more apt to be seen in storage than in the field in Western Ontario. It is practically impossible to detect slightly water-cored turnips without cutting them. Severely diseased turnips may be off shape and have a rough, corky to leathery skin.

Control

This disease is caused by lack of available boron in the soil. Soil applications of borax before seeding have not been successful in many districts possibly because of the high lime content of the soil. **Water-core can be controlled by spraying or by dusting the leaves.** If soil applications of borax must be resorted to because of lack of spray or dust equipment, broadcast **granulated** borax **after** thinning rather than before seeding, at the rate of 20 to 30 lbs. per acre with a hand, cyclone grass seeder.



Water-core.

DIRECTIONS FOR SPRAYING

THE SPRAYER

A power sprayer, either wheel or motor driven, that will give at least 125 lbs. pressure is preferred. A good agitator in the tanks is necessary. Use 3 spray nozzles per row, the centre one directed down on the leaves and the two side nozzles set as low as possible and directed toward each other. With a 4-row, hand-pump barrel sprayer, use three nozzles per row as described above and spray only 2 rows at a time. Forty to sixty gallons of spray should be applied per acre, depending on the size of the leaves.

WHEN TO SPRAY

Thoroughly spray the leaves when the roots are 1 to 1½ inches across (about the thickness of one's thumb).

MATERIALS TO USE

Borax—Obtainable from fertilizer and spray companies but should be ground finer than table salt. Borax contains boron, the material necessary to prevent water-core.

Bentonite Clay—Obtainable from fungicidal spray companies. The Niagara Brand Spray Co., Burlington, Ont. has it in stock. This holds the borax on the leaves so it will not be washed off by rains.

Orthex (liquid form)—Obtainable from fungicidal spray companies. This material is used to make the spray spread evenly over the leaves and also to help make the spray stick to the leaves.

Seed dealers can obtain these supplies. The Niagara Brand Spray Co., Burlington, Ont. mixes the borax and bentonite clay ready to use and is sold as "Niagara Turnip Spray Mixture" in 50-lb. bags.

MAKING UP THE SPRAY

If the borax and bentonite clay are not already mixed when purchased, thoroughly mix them while still dry in the proportions of 12 lbs. of borax to 3 lbs. of bentonite clay. Almost fill the spray tank with water. For each 40 gallons of water slowly add 15 lbs. of the borax-clay mixture while stirring rapidly. Then stir in 2 to 2½ cups of Orthex for each 40 gallons. Add enough water to fill the tank.

DIRECTIONS FOR DUSTING

THE DUSTER

Potato dusters, also a large pea duster, have been used with good success. An apron should be used to assist in getting as much dust as possible on the lower sides of the leaves. From the results so far it does not seem to make any difference as to the time of day the dust is applied. However the dust outlets may clog if the leaves are very wet.

WHEN TO DUST

Similar to that described for spraying.

MATERIALS

The Bartlett Spray Works, Beamsville, Ont., also the Niagara Brand Spray Co., Burlington, Ont., prepare the borax-dust mixture ready to use.

DUST APPLICATION

Apply 40 to 50 lbs. of the dust to each acre of turnips. If using a potato duster it may be necessary to suspend a weight on top of the dust to prevent arching of dust at the bottom of the hopper.

TURNIP ROTS AND THEIR CONTROL

J. D. MacLachlan, Department of Botany, O.A.C.
E. H. Garrard, Department of Bacteriology, O.A.C.

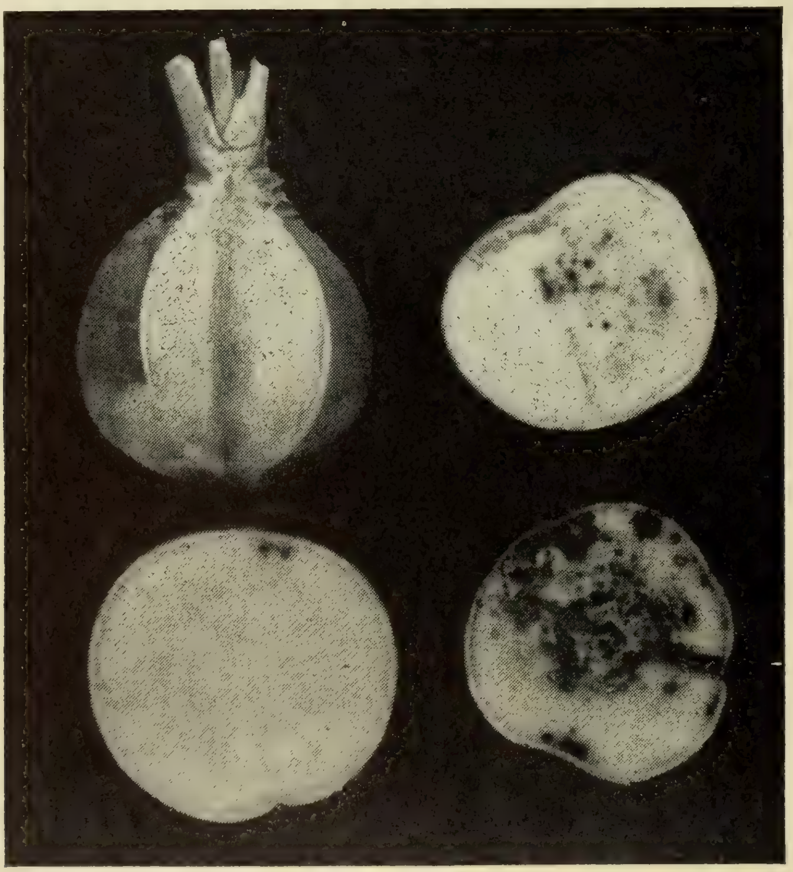
The following is a description of the important rots in turnips and the most effective known means of control.

Black Rot

(Caused by Xanthomonas campestris (Pammel) Bergey et al)

DESCRIPTION

The disease gets started in the field from using untreated seed and from diseased turnip or rape refuse remaining in the soil from previous years or brought to the field in manure. It may also start from neighbouring diseased fields. At first scattered diseased plants will occur throughout the field and are often unnoticed by the grower. From these diseased plants, however, the bacteria causing the disease are spread by wind, rain and insects to various parts of the field where they attack healthy plants. The disease is first seen on these plants as yellowish areas usually near the margin of the leaf; the veins in these areas are often blackened. The bacteria work down through the leaves, killing the leaf tissue as they go, and finally get into the root. There, they cause black streaks just under the rind or black areas throughout the flesh and render the turnip unfit for sale. The same bacteria will attack other closely related plants such as rape, cabbage and cauliflower.



Black rot (upper right) rind removed from one side of a turnip to show characteristic black streaks. (Other three) cut turnips showing various amounts of disease.

CONTROL

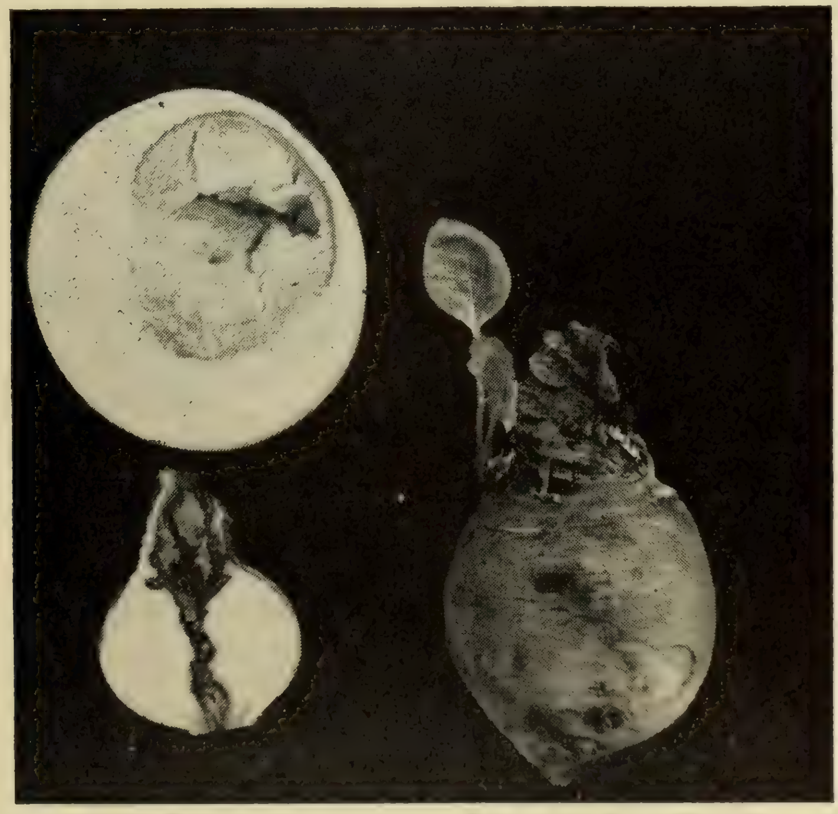
1. Practise as long a rotation as possible so that the bacteria causing this disease and remaining in the soil will die out. A four or five year rotation should be ample if rape, cabbage or cauliflower have not been included.
2. Avoid putting manure containing turnip refuse on a field in which turnips are to be grown. It is also advisable not to use manure from stock fed on diseased turnips.
3. Use treated seed. If the seed has not been treated with a mercury compound when purchased, it can easily be done. One of the simplest and easiest is the use of Semesan dust. It is available in most places where turnip seed is sold and a 15c package treats 5 lbs of seed; this is at the rate of one-half level teaspoonful of the dust to one pound of seed. Half fill a large glass bottle such as a gallon vinegar bottle, or tin container which is fitted with a tight-fitting top, with seed, add the proper amount of dust and shake thoroughly until the dust is uniformly distributed over the seed. The seed can be treated any time prior to sowing and it is well worth the effort and small expense. Caution—Semesan is poisonous; avoid breathing the dust.

Soft Rot or Neck Rot

(Caused by Erwinia carotovora Jones)

DESCRIPTION

Evident in the field as sickly tops, or if one attempts to pull a turnip with an apparently healthy top the latter breaks away readily at the neck revealing a soft rotten mass. The flesh of the turnip may be partially or almost entirely decayed into a soft jelly-like mass with no distinct odour at first but later becoming putrid. The disease may start in the field and increase during storage. It is caused by a different bacterium from the one which causes Black Rot. It should not be confused with water-core.



Soft Rot (lower right) diseased turnips from which the top has fallen away because the neck was rotten. (Other two) cut turnips to show soft jelly-like rot.

CONTROL

Seed treatment is not known to control this disease but the cultural practices already described for the control of Bacterial Black Rot should assist materially in lessening the amount of this trouble. In a field where Soft Rot has been present do not grow, for at least four years, truck or vegetable crops such as mangels, carrots, cabbage, cauliflower, beets, onions, rape and lettuce. Even potatoes may be affected. Never put turnips containing Soft Rot in storage because it will spread rapidly to other turnips.

Skin Rot or Phoma Rot

(Caused by Phoma lingam (Tode) Desm.)

DESCRIPTION

Skin Rot is primarily a storage trouble. This disease begins in the field where it may sometimes be seen as a dry rot around the neck, but more often it is not detected until after the turnips have been stored for some time. During storage the disease appears in the skin as scattered, dry, sunken spots bordered by dark areas. If diseased turnips are waxed they will rot rapidly. The bacteria causing Soft Rot often attack turnips with Skin Rot.

CONTROL

1. So far as is known, seed treatment will not prevent this disease.
2. Practise a long rotation because this disease starts in the field.
3. Avoid putting manure containing turnip refuse on a field in which turnips are to be grown. It is also advisable not to use manure from stock fed on diseased turnips.
4. Keep the storage as close to 32° F. as possible and have sufficient air circulation to prevent sweating.
5. If diseased turnips have been stored, thoroughly clean the storage room after the turnips have been removed. (See under Storage.).

TURNIP INSECTS AND THEIR CONTROL

R. W. Thompson, Provincial Entomologist, Department of Entomology, O.A.C.

The important insects causing damage to the turnip crop in Ontario are the striped flea beetle, cabbage and turnip aphids (lice), cabbage maggot and to a lesser extent three or four caterpillars which feed on the leaves of the plants. These insects are discussed below in order of their appearance in the field throughout the growing season.

Striped Flea Beetle

(Phyllotreta vittata (F.)

DESCRIPTION

Small black beetles, 1/12 inch long with a wavy, inconspicuous yellow stripe down each wing cover. These beetles hop like fleas and thus are often called the "turnip fly". They attack the young plants shortly after they come through the ground and may eat so many holes in the leaves that the plants wither and die.

CONTROL

1. Treating the seed with turpentine has no value.
2. Destroy weeds of the mustard family such as all kinds of mustard, peppergrass and shepherd's purse.
3. Dust the young plants, if attacked, with 3% DDT dust. If spraying is the alternative to be followed, spray the young plants with 50% DDT wettable spray powder at the rate of 1 lb. to 40 gals. water.
4. Turnips sown after June 21st. are seldom severely injured. If early sown turnips are destroyed it is usually safe to resow, the second planting generally being free from flea beetle attack.

Cabbage and Turnip Aphids

Brevicoryne brassicae (L.) and Rhopalosiphum pseudobrassicae (Davis)

DESCRIPTION

Aphids or lice are the most important insect enemies of turnips in an average year and often cause serious losses in a relatively short time. The aphids or lice are usually found on the underside of the leaf but when severe may cover not only that side of the leaf but are found in large numbers on the upper surface. Winged females spread the aphids from plant to plant. Aphids or lice are sucking insects and by extracting the leaf juice cause the leaves to crinkle, then turn yellow and either die or become very badly dwarfed. Attacks early in the season may kill the young plants. Heavy infestations later in the season frequently destroy all the leaves in a turnip patch within a period of a week or ten days. Severely infested fields give off a strong odour of decay.

CONTROL

Attempts to control these insects with insecticides have up to the present not met with any outstanding success, paricularly from the standpoint of dust applications. Points which should be kept in mind because of these conditions, however, are:

1. After the aphids have spread over the turnip field it is too late to attempt control because there is apparently no equipment yet available with which the aphids on the underside of the leaves can be destroyed.
2. Because of the difficulty in controlling the insects, prevention plays a big part in satisfactory turnip production. Be on the watch for the first infested areas in

the field. These areas are at first small and usually found within the first ten rows around the field. Destroy the aphids in these infested areas by

(a) thoroughly spraying both sides of the leaves of infested plants with a solution of 1 lb. of linseed oil soap in 10 gals. water or
(b) pulling the infested plants and burying on the spot. **It is important that this be done while the infested areas are small,** otherwise the winged females will have spread the aphids to other parts of the field.

3. Plough down all turnip refuse in the late fall.

Cabbage Maggot

Hylemya brassicae (Bouche)

DESCRIPTION

During the past two or three years this insect has caused increasing injury in fields of table turnips. In some seasons it has been responsible for more monetary loss than the turnip aphids or lice. The damage is most commonly seen in late summer or early fall as shallow tunnels here and there over the surface of the turnip beneath the soil level. In addition, however, deep tunnels may be found which reach almost to the centre of the turnip and in these small, white maggots about ¼ inch long when full grown may be found.

CONTROL

Through the years when this insect was considered solely a cabbage, cauliflower and radish pest, control on these crops was feasible by means of a mercuric chloride solution. This solution is still the accepted control in Ontario for maggot in cabbage, cauliflower and radish. In the case of turnips the cost of mercuric chloride is too high. Moreover, since the attack of this insect on turnips is by the second and third generations of flies, timing of the application is difficult owing to a prolonged egg-laying period. Dusts which have been tried to date have been of no apparent value. Various new insecticides are being tested in the hope of finding a commercial control.

Care should be exercised in the preparation of the turnip field. Experience has shown that the adult flies are attracted to barnyard manure and also to decaying vegetable matter, consequently manure or sod should be ploughed under carefully in the fall and in the spring should be worked with a disc so that the manure or sod or both are left at a reasonably good depth in the soil.

Leaf-Eating Caterpillars (Worms)

DESCRIPTION

There are several species of "worms" (caterpillars) that attack the leaves of turnips. Most years the injury is not severe. Four of the more common forms are (1) **Imported Cabbage Worm (Pieris rapae** (L.) (adult is the cabbage butterfly), (2) **Cabbage Looper (Trichoplusia ni** (Hbn.), (3) **Diamond-Back Moth (Plutella maculipennis** (Curt.) and (4) **ZEBRA CATERPILLAR (Ceramica picta** (Harr.). The adults of the last three are moths.

CONTROL

Most years no control is necessary. Any of these leaf-eating "worms" can be controlled by DDT as a dust or spray. For information write to the Provincial Entomologist, Ontario Agricultural College, Guelph.

THE STORAGE OF TURNIP ROOTS FOR WAXING

J. H. L. Truscott, Department of Horticulture, O.A.C.

This article must be so brief that it is not possible to discuss such matters as storage construction and operation. Nor is it possible to give the reasons for the following recommendations. It is sufficient for present purposes to say that the recommendations are based on both experiments and practice. Then, if the reader is willing to spend the time necessary to understand the details of construction and management of storages, and to spend enough money to build and equip a storage, that information is available.

1. Store turnips at 31° to 32°F. continuously.
2. Store only sound turnips of suitable size.
3. Hold the humidity high by keeping the floor wet.
4. Do not pile turnips against the wall or on the floor of the storage room. Use a bin construction so that air can circulate all around the turnips.
5. No turnip root should be more than three feet away from circulating air. That means that turnips should not be piled more than six feet deep in a bin with a slatted floor.
6. Clean out the storage at the end of the storage season and then spray it thoroughly with 2% bluestone (copper sulphate) in water to which has been added some hydrated lime. A 2% bluestone solution is made by dissolving 2 pounds of bluestone in 10 gallons of water. Add from 2 to 4 pounds of hydrated lime and keep it stirred while doing the spraying. Use only freshly prepared mixture.

BETTER ONTARIO PASTURES

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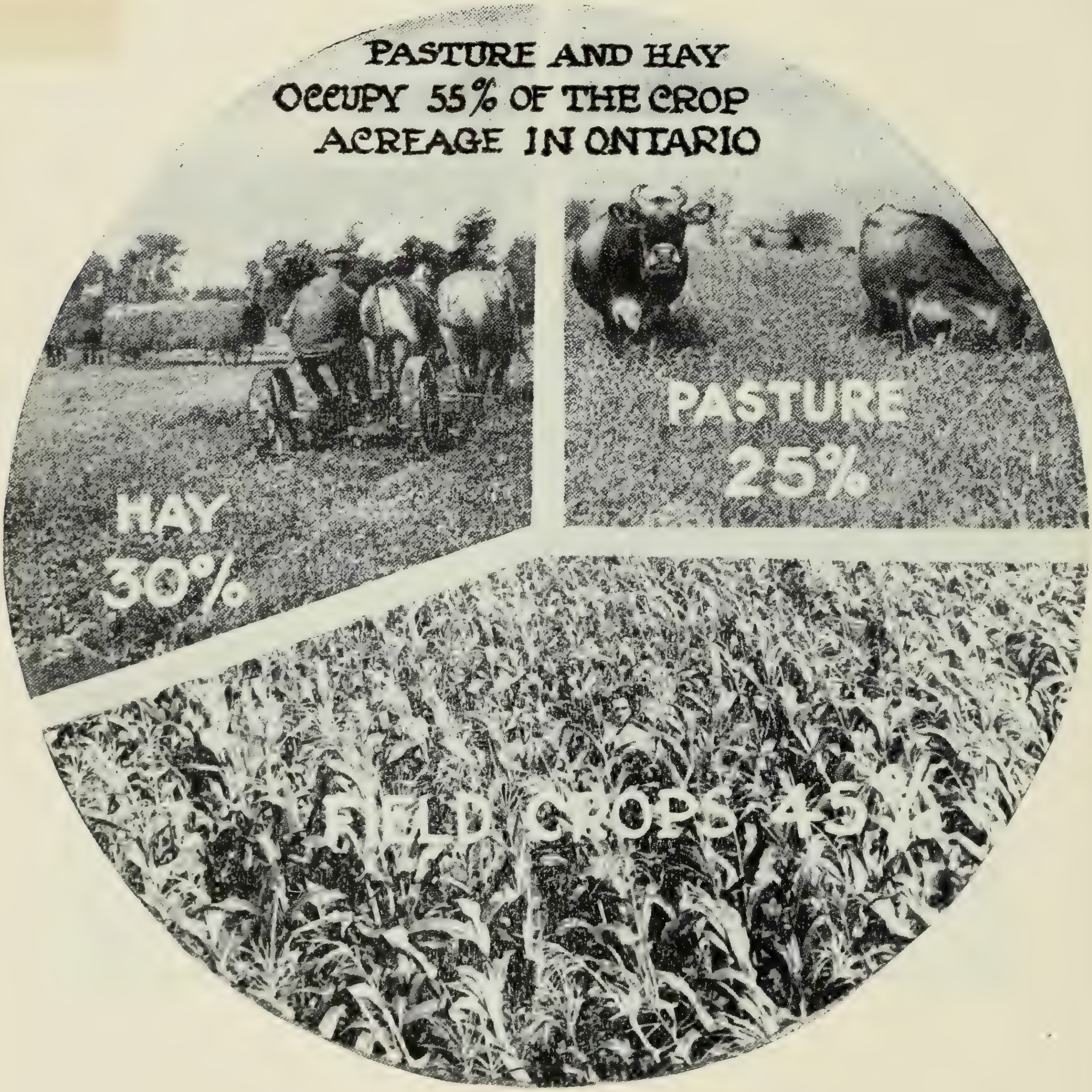
BETTER PASTURES INCREASE PROFITS

ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 450 • **JUNE, 1947**

BETTER ONTARIO PASTURES

PASTURE furnishes the **most economical returns** of livestock products. Although we have a rather short grazing season in Ontario, the importance of our pasture land is shown by the fact that we have approximately three million acres under production. Despite this comparatively large acreage, and the importance of this crop in Ontario, a beef and dairy province, **not sufficient care** is given to our pastures.



"Pasture is a major farm crop in Ontario".

In most of the major beef and dairy areas the original vegetation was forest. This wooded condition is the type of vegetation best suited to our soil and climate. The land was cleared, but if it were allowed to remain unmolested would return to this condition in a series of orderly changes.

We have all seen these various stages at some time or other on our farms, or throughout the country. A fallow field will grow up with annual weeds, which in turn will be replaced by perennial grasses and weeds. One of the **most common perennial grasses** found in this stage is **Kentucky Blue Grass.** These meadows will be invaded by low growing shrubs and bushes which in turn will be replaced by trees. Thus it will be seen **that it is impossible in these areas** to have such a condition as a **truly permanent pasture.**

All the grasses and legumes grown in our hay and pasture mixtures today are introduced species which have had to become adjusted to our local environmental conditions. This adjustment has been greatly hastened by breeding and selecting improved strains of these introductions for adaptability, palatability, yield, nutritional content, disease resistance and other desirable agronomic characters.

For **economical returns** from our pasture lands in Ontario we must have:

(1) GOOD SEED MIXTURES
(2) GOOD SOIL PREPARATION
(3) GOOD SEEDING METHODS
(4) GOOD AFTER-SEEDING MANAGEMENT

GOOD SEED MIXTURES

While forage plants grow over a wide range of soils and climate they prefer certain specific environmental conditions. It is always good practice to grow those **varieties** or types **adapted to the soil and climate** found on any particular area. Forage plants should be selected also for their **adaptability** to the **purpose** for which they will be used, that is, for hay and pasture in an ordinary farm rotation, or the establishment of a long term pasture.

It is seldom advisable to sow a single species of grass or legume for either hay or pasture, except where pure stands are being grown for seed increase. A mixture of grasses and legumes has many advantages. **Legumes** help to **maintain fertility** and provide a better balanced ration. Mixtures of several grasses and legumes result in a more uniform stand, as soil conditions vary and species differ in periods of peak production. Moreover, grasses do better in association with legumes than when grown alone. In case one species is killed out, others present will tend to spread and maintain a uniform turf.

Since it is impossible in this bulletin to list mixtures suitable for all Ontario conditions, an attempt will be made to give recommended mixtures for the major areas. Changes in the species of forage crops used and the rate of seeding may be made, depending on the particular environment and the availability of the seed. Too much deviation, however, is not advised, as basically these mixtures are composed of legumes and grasses which have proven themselves satisfactory under Ontario conditions. The amount of each variety in the mixture has been determined to give the **proper proportion** of **legumes** and **grasses** necessary for a high quality pasture. Caution should be observed about including varieties in a mixture unless the use of this variety is recommended by a proper source. Grasses and legumes are perennial crops and have to remain in the ground for a number of years. **Non-hardy varieties will not overwinter** and hence their value is lost, as well as providing bare areas in the stand where undesirable grasses and weeds may become established. Under normal conditions we have several weeks of dry, hot weather in mid summer, and consequently must have varieties which will be productive through this period, or our returns will drop. Also, we must have **varieties which grow early and rapidly in the spring and late in the autumn** when the temperatures are relatively low.

LONG TERM PASTURES

These are pastures that have been sown to improved strains of grasses and legumes for the purpose of remaining productive for a considerable time. While this time varies greatly with certain factors it is generally understood to be for a period of **at least ten to twelve years.** It will be seen that the major species must be those capable of remaining productive in the ground for a long time. It will be evident also that this land must be removed from the general farm rotation programme. The fact that some of our most productive grasses and legumes are relatively short lived makes it much more difficult to maintain a proper proportion of grasses and legumes in the later years of a long term mixture. Also we must not overlook the **benefit of the shorter lived legumes on soil improvement.** Experimental work conducted by the Departments of Field Husbandry and Animal Nutrition at the Ontario Agricultural College on long term pastures indicates the **necessity** of including in the mixture a **generous proportion of high producing legumes.** Not only were the total **yields** for the season greatly **increased,** but the **protein** and **mineral content** of the fodder was **much higher.** The increased returns of the **legume-grass mixture** over the predominately grass mixture were **much greater during the dry summer period of July and August.** This is one of the major critical periods of our pasture programme, and anything done to strengthen this weakness will greatly add to the carrying capacity of the pastures and the economy of our beef and dairy production. Since the legumes come into full production in the early years after seeding they serve to keep up the yield until the grasses become more fully established.

The following long term pasture mixtures are recommended for the major areas of Ontario:

MIXTURE 1

Long Term Pasture Mixture for Well-Drained Clay-Loam Soils of Average Fertility.

Alfalfa	6	pounds
White Dutch Clover	1	"
Ladino Clover	1	"
Timothy	5	"
Brome Grass	4	"
Orchard Grass	4	"
Meadow Fescue	3	"
Total	24	pounds per acre

MIXTURE 2

Long Term Pasture Mixture for Well-Drained Heavy Clay Soils.

Alfalfa	5	pounds
Alsike	2	"
White Dutch or Ladino Clover	1	"
Timothy	5	"
Meadow Fescue	3	"
Brome Grass	4	"
Orchard Grass	2	"
Total	22	pounds per acre

MIXTURE 3

Long Term Pasture Mixture for Light, Sandy and Gravelly Soils

Alfalfa	5 pounds
White Dutch Clover	1 "
Sweet Clover	3 "
Timothy	4 "
Brome Grass	5 "
Orchard Grass	3 "
Red Fescue	2 "
Canada Blue	3 "
Total	26 pounds per acre

MIXTURE 4

Long Term Pasture Mixture for Low-Lying Poorly Drained Soils Subject to Flooding.

Timothy	5 pounds
Red Top	2 "
Reed Canary Grass	6 "
Meadow Fescue	4 "
Alsike	3 "
Total	20 pounds per acre

The above mixtures differ in the kinds and amounts of the different species of grasses and legumes, based on the response of the species to varying environmental conditions. In the heavier clay soils Alsike is used to partially replace White Dutch Clover. The amount of Orchard Grass is lowered in favour of Brome Grass. On the lighter soils the amount of low growing clovers is reduced, and the legume content maintained by including Sweet Clover. Red Fescue and Canada Blue Grass are species which do better under these soil and moisture conditions than some of the other grasses.

On low lying poorly drained soils which suffer periodically from flooding Reed Canary Grass has been found very valuable. Alfalfa has been eliminated and the rate of Alsike increased. Red Top has also proven a valuable asset to such a mixture.

Long term mixtures may be seeded either with or without a nurse crop. Experience has shown that thicker pasture stands result when the nurse crop is not seeded too heavily. A light seeding of **early oats** at not more than **one to one-and-a-quarter bushels per acre** has been found to be satisfactory in this connection. This may be pastured, removed as hay, or harvested for grain. When either of the last two methods is used care must be taken to prevent the killing out of the newly seeded grasses and legumes by stooks or coils left in one place too long.

If immediate pasture is desired **Perennial Rye Grass at six to eight pounds per acre** may be added to the mixture, and will function as a nurse crop in place of grazing. Where this method is used it is desirable to clip the mixture with sufficient frequency to prevent weeds going to seed.

HAY-PASTURE MIXTURES

A large number of Ontario farmers interested in beef and dairy production have a well planned crop rotation. Any use of the land which upsets this system is disturbing to the farm programme. One becomes very hesitant about removing the best land from this rotation to place in a long term pasture. If these fields are not removed from the rotation **we still are using our best land in growing our most economical crop.** As mentioned above, experimental work has demonstrated the desirability of including legumes in pasture mixtures. Here is provided an opportunity to combine our hay and pasture requirements, and include the most productive grass and legume varieties without disturbing our crop planning. It also provides the best arrangement for soil improvement, and allows for frequent alternation of different crops.

The following hay-pasture mixtures are recommended for two of the major areas of Ontario. Low lying, poorly drained soils subject to flooding are being treated as a long term pasture proposition.

MIXTURE 5

Hay-Pasture Mixture for Well Drained Clay Loam and Clay Soils of Average Fertility.

Alfalfa	6	pounds
Red Clover	4	"
*Ladino or White Dutch Clover	2	"
Timothy	5	"
Brome Grass	5	"
Orchard Grass	4	"
Total	26	pounds per acre

*For heavy clay soils not well drained, decrease Alfalfa and include Alsike in place of Ladino or White Dutch Clover.

MIXTURE 6

Hay-Pasture Mixture for Light Sandy and Gravelly Soil.

Alfalfa	4	pounds
Sweet Clover	4	"
Timothy	3	"
Brome Grass	6	"
Orchard Grass	3	"
Total	20	pounds per acre

Mixtures 5 and 6 differ according to the response of the grasses and legumes to these two major soil types. Red Clover, Alfalfa, and Ladino or White Dutch Clover are used on the heavier soils, while Alfalfa and Sweet Clover are used on the lighter soils. The rate of Brome is increased on the lighter soils, while the amount of Orchard Grass and Timothy is decreased. A lower rate of seeding is used on the lighter soils.

Since hay-pasture mixtures are of short term duration and are being included in the regular farm rotation, it is probable that they will be seeded with a nurse crop. **Early oats** at not more than **one to one-and-quarter bushels per acre,** or **barley at one bushel per acre** is recommended.

GOOD SOIL PREPARATION

The most favourable conditions for the successful establishment of seedlings are a **firm seed bed** with **adequate moisture** and **soil fertility,** a fairly cool temperature and a **thinly sown nurse crop.** Quick germination of seeds in a firm, compact, moist soil, seldom fails to bring good results. Best results have been obtained where the soil has been **well cultivated, harrowed,** and then **culti-packed** to firm the seed bed. In certain types of soil where baking is a problem it may be necessary to dispense with the packing operation. Representative soil samples should be taken and sent to the nearest Soil Testing Laboratory, or the Soils Department, Ontario Agricultural College, Guelph, for analysis.

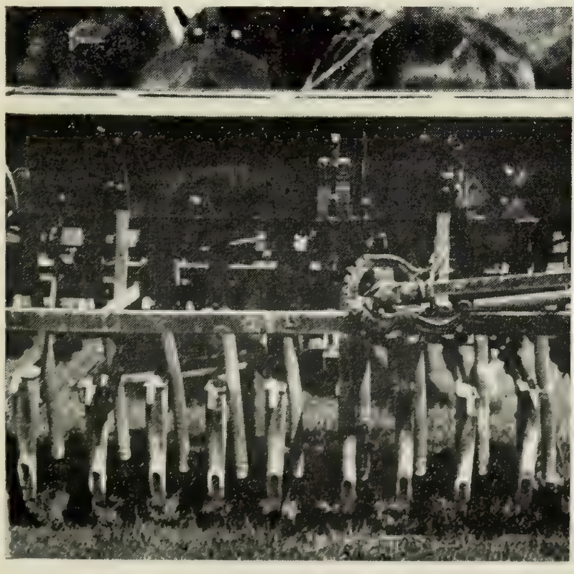
Recommendations from this analysis should be followed in order to bring the soil to the required level of fertility.

Fields should be selected in which the previous cropping practices have insured freedom against weeds during the establishment of the stand.

GOOD SEEDING METHODS

Grasses may be sown in the fall from September first to fifteenth **or in the spring** as soon as the land is in shape for seeding. **Legumes should be sown only in the spring.** The grass varieties are often seeded with winter wheat as the nurse crop and the legume varieties broadcast on the stand in early spring.

Hay-pasture mixtures are usually seeded through the grass seeding attachment of a seeder, while the regular crop is planted by means of the grain box. With long term mixtures every care should be taken to give the young plants all the advantages possible. One of the recommended methods of seeding such mixtures is to **sow the nurse crop and fertilizer first at the regular depth.** The field should then be **cultipacked or rolled,** and the **mixture seeded through the grain box on the wheat side** with the **indicator set at approximately four pecks per acre.** If **Perennial Rye Grass** is included the indicator should be moved up to **six pecks per acre.** Some grain drills vary individually in their rate of seeding and should be checked the first round for proper calibration. The grain spouts should be removed from the drill.



"Seed drill with grain spouts removed for seeding pasture mixture."

"Cyclone Hand Seeder."

Another method of seeding that has been widely used, and which has proven satisfactory in most cases is **to seed the grasses and legumes with the exception of the Brome Grass through the grass seed attachment of the drill.** The Brome may be broadcast alone before the other seeds are planted, or if a nurse crop is used, the Brome may be mixed with it and both seeded shallow. **The depth of seeding Brome Grass should not exceed three-quarters of an inch on average soils** and not more than **one inch on lighter, sandy soils,** when sown with the grain drill.

Under special conditions, where it is impracticable to use the seed drill the Cyclone Hand Seeder has proven useful in seeding grass and legume mixtures. Since forage seeds differ greatly in weight there is a tendency for the heavier seeds to be thrown farther than the light seeds, resulting in a streaked stand. This can be overcome in part by dividing the seed and sowing in two directions. Seeding legumes in the spring on winter wheat stands or the reseeding of old pastures might be done by this method. Where Brome Grass is included it should not be seeded with the other varieties.

Because grass and legume seeds are very small, and the young plants delicate, the depth of seeding is an important factor in establishing a good stand. **Under average conditions seeding should not be at a greater depth than from one-half to one inch.**

GOOD AFTER-SEEDING MANAGEMENT

The quantity, quality and duration of a well established pasture is dependent to a large extent on the management it receives.

1. It is essential that grazing of seeded pastures should commence early in the spring so that the tall growing grasses and legumes do not smother the bottom grasses and small clovers. However, avoid grazing in the spring before the ground has become sufficiently firm to withstand tramping. **Do not graze before the fresh growth is four inches to six inches tall.** In order to keep the pasture short it is often necessary to carry more stock early in the spring, or part of the field may be separated by

"Undergrazing results in low quality pastures."

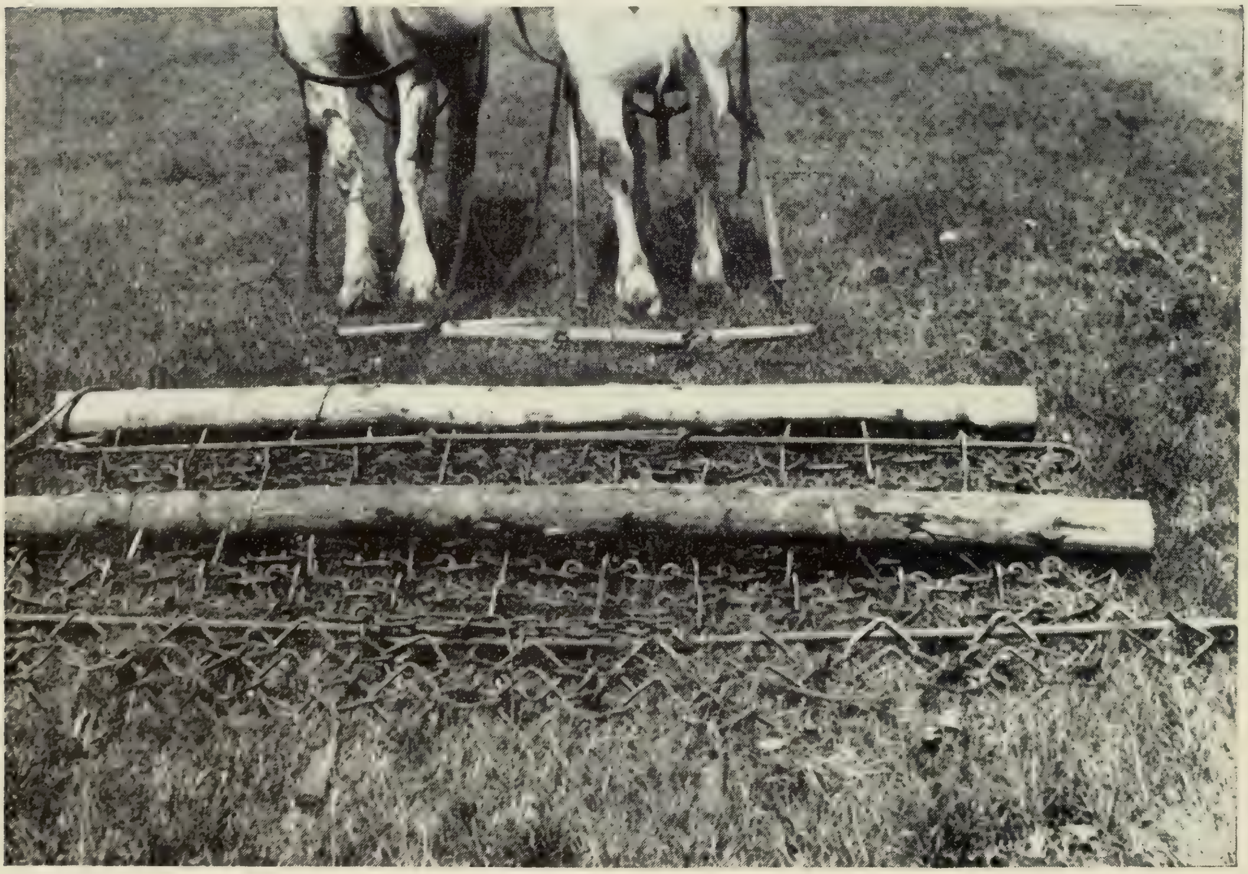
means of an electric fence and cut for hay, thereby reducing the acreage for pasture. In mid-summer the entire field may be used as pasture.

2. If there is insufficient livestock to control the growth it is a good policy **to clip the pastures with a mower,** the cutting bar of which has been raised. One cutting in the later part of June and a second cutting in early September should be sufficient. This helps to control the weeds, especially the first season after seeding, and encourages a more even stand of plants of the various species included in the mixtures. If weeds with a quick recovery are present it may be necessary to clip more frequently. This also tends to thicken the pasture stand.

"Pastures should be clipped to control weeds and prevent too coarse a growth."

3. **Top dressing pastures in the fall with barnyard manure and with commercial fertilizers** has proven a very desirable practice. Fertilizers can be applied in the fall before growth has ceased, or very early in the spring, before growth has commenced. If an application of manure has been given in the fall, fertilizer may best be applied in the spring. For pastures a complete fertilizer usually gives the best results. Grasses respond to nitrogen, clovers respond to phosphorus. A **4-12-6 or 4-8-12 fertilizer** is satisfactory at **250 pounds per acre,** or at a rate depending on the soil analysis. **Light top dressings of manure, five to ten tons per acre, preferably phosphated, applied in the fall before growth has stopped,** is the rate suggested in pasture maintenance. If applied in September or early October, it will strengthen the growth, increase the winter hardiness, and give a protecting coverage. For further information with regard to the fertility of pasture lands consult the **latest** edition of **"Recommendations for Soil Management and Use of Fertilizers"**, prepared by the Advisory Fertilized Board for Ontario and available at the Ontario Agricultural College.

"Light top dressings of manure, five to ten tons per acre, applied in the fall before growth has stopped, is excellent pasture management."



"The spreading of droppings by means of a drag harrow is desirable in the maintenance of a uniform turf."

4. **The spreading of droppings whenever necessary by means of a drag harrow** is desirable in the maintenance of a uniform turf. It also increases the palatability of pastures which are heavily grazed.

5. **Rotational grazing** has proven an **excellent aid** in maintaining a continuous **supply of short, young grass.** The use of an electric fence provides an easy means of dividing pastures into convenient lots for this type of grazing.

"Rotational grazing has proven an excellent aid in maintaining a continuous supply of short, young grass."

6. **Pastures should not be grazed too late in the fall.** They should be allowed to obtain a fair top growth in order to store an adequate food supply to withstand winter conditions and commence growth early in the spring.

AFTERMATH PASTURES

Most Ontario farmers keeping livestock have a well developed hay programme. If the **hay is cut** at the **proper stage of development** for the **greatest yield of nutrients** there is considerable time left for further growth. This is used very successfully as a source of pasture on many farms. A greater advantage can be made of this aftermath pasture if care is taken to include varieties of grasses and legumes in the mixture which produce a quick growth after cutting. Alfalfa, Ladino, Orchard Grass and Brome have proven very satisfactory in this regard. **Aftermath pastures should not be grazed too late in the season, as such practice impairs next season's growth.**

UNIMPROVED PASTURES

This group includes such areas as woodlots, rough hill land, river bottoms and other types in which the land is unsuitable for tilling. It is needless to say that there are vast areas of such types of pasture throughout the country which play an important part in maintaining livestock.

Improvement practices on these pastures are rather unsatisfactory, as proper soil preparation and usual methods of seeding cannot be employed. The amount to be expended on such practices is obviously governed by the state and topography of the land and the necessity for using these sub-

"Vast areas of such types of abandoned pasture throughout the country play an important part in maintaining livestock."

marginal areas. In many cases **raising the fertility level of the soil by top dressing with barnyard manure or commercial fertilizers** has given **good results.** This is particularly true when soil impoverishment is the main cause of lack of production. The application of **phosphate fertilizer** promotes the **establishment of legumes** which increases the value of the fodder and helps the soil, while the use of **nitrogenous fertilizers** assists the **grass development.** Even if the land can be cultivated or harrowed, more **desirable** grass **types** may be introduced by **broadcasting seed of certain recommended grass and legume varieties** as Orchard, Brome, Timothy, Kentucky Blue Grass, Alfalfa, and White Dutch Clover. Probably it is not economical to use too expensive a mixture under such adverse conditions.

N.B.—Photographs through the courtesy of the Department of Public Relations, Ontario Agricultural College.

VEGETABLE VARIETIES AND HYBRIDS

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By T. O. GRAHAM and J. S. SHOEMAKER

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ONTARIO DEPARTMENT of AGRICULTURE
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VEGETABLE VARIETIES AND HYBRIDS

by

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INTRODUCTION

A suitable variety or hybrid is the cornerstone of successful vegetable growing. The grower who sows seed of an inferior variety or hybrid is severely handicapped from the start.

There are basic differences between a variety and a hybrid. In a variety, the seed for the crop is produced through pollination which is not controlled. Trueness to varietal type is maintained by elimination of off-types and by selection. In a hybrid, the seed for the crop is produced as a result of controlled pollination (see, for example, under sweet corn).

More attention, both professional and in practice, probably has been given to a consideration of varieties and hybrids than to any other phase of vegetable growing. In spite of the accumulation of much information on varieties and hybrids, the selection of the best ones for any given location or conditions remains a serious and difficult problem.

There are many varieties of most kinds of vegetables and the number of hybrids is increasing. To get to know varieties or hybrids and to bring order out of what may seem to be hopeless confusion, it is necessary to be familiar with classes or groups of similar characteristics. The average person cannot hope to carry in mind all the characteristics of each variety or hybrid but familiarity with the main features on which groups are arranged will, in most cases, provide general essential information.

It would be easy to obtain many illustrations which would show great variation in a given variety. Therefore, the factors of type and strain assume great significance. Only a few vegetables, such as rhubarb, are propagated vegetatively as is the case in the nursery practice of budding fruit trees. Frequently the difference between strains of a certain kind of vegetable is greater than that between varieties of the same vegetable. The growers of vegetable seeds differ in their ideas of what constitutes the most desirable type for a variety. In the same variety one type may be selected out or built up by seed growers for a particular area or condition, whereas another type of the same variety may be considered typical in other areas.

The quality of vegetable seed may vary considerably with the procedure in producing it. High quality in seed depends on more than good germination, as other factors, such as are ultimately reflected in the crop harvested, demand their full share of attention. Knowledge of seed production practices is significant but is too large a subject to discuss here. It is very important that seed be used which is capable of producing the results expected, and large growers in particular, who buy seed in quantity, are well advised to give careful consideration to their source of seed.

There is an old adage to the effect that "all varieties are characterized by their faults." In the case of most of the varieties and hybrids which are emphasized in the later discussion, the merits outweigh the faults and therefore they are the leading ones of their kind, or they are listed or described for certain particular reasons. New varieties and hybrids are continually appearing. Even though they are often older ones renamed, many introductions have come to the fore because of both general advantages such as higher yield and better appearance, or particular merits such as resistance to disease.

The information presented in this bulletin is based on special tests of varieties and hybrids and on opinions which have resulted from observation of the behaviour of various varieties when grown over a range of conditions for both general purposes in home, market, and truck gardens, and for particular purposes such as canning and freezing. A wide range of climatic conditions occurs in Ontario, and so there is a difference in the adaptability of varieties to various districts.

ASPARAGUS

Mary Washington is outstanding. The spears are, as a rule, dark green with a heavy purplish tinge towards the tip, with a tightly pointed bud. Branching out does not take place until the spears are well above market length. This last feature renders the variety highly desirable for market and, coupled with rust resistance, makes it superior to all others. **Martha Washington** is also an excellent variety. It is somewhat superior to Mary Washington in resistance to rust but not in other respects. **Paradise** seems no better than a good strain of Mary Washington. **Seneca Washington** represents progeny of a cross of male and female plants selected for yield, size of shoot, and uniformity. **Vineland No. 35,** derived from two selected heavy-producing plants of Mary Washington, is under test with Ontario growers. It is large in size and heavy yielding.

BEAN

All bean pods are green when they are young, but some turn white, yellow or crystal (nearly colourless or rather translucent) as they approach an edible stage. Yellow types are called wax beans.

1. *Pole Garden Beans*

The distinction between the pole and bush types is due to a single pair of characteristics: the indeterminate growth habit (axillary inflorescence, and so the stems may elongate indefinitely) of the pole bean is dominant over the determinate habit (main axis terminates in a flower cluster, thus preventing stem elongation) of the bush bean. Beans that climb do so by virtue of their sinuous, twining stems. The absence of tendrils or tendril leaves in beans distinguishes them in one way from peas. The ability to climb is a constant character but does not allow separation into this class until the plants are well along in growth.

Pole beans are usually later than bush beans but bear for a longer period where climate permits, and some produce longer pods. This type is important commercially in canning areas in the West where the extra cost of handling is more than offset by the yield and price. The use in Ontario is largely restricted to home gardens.

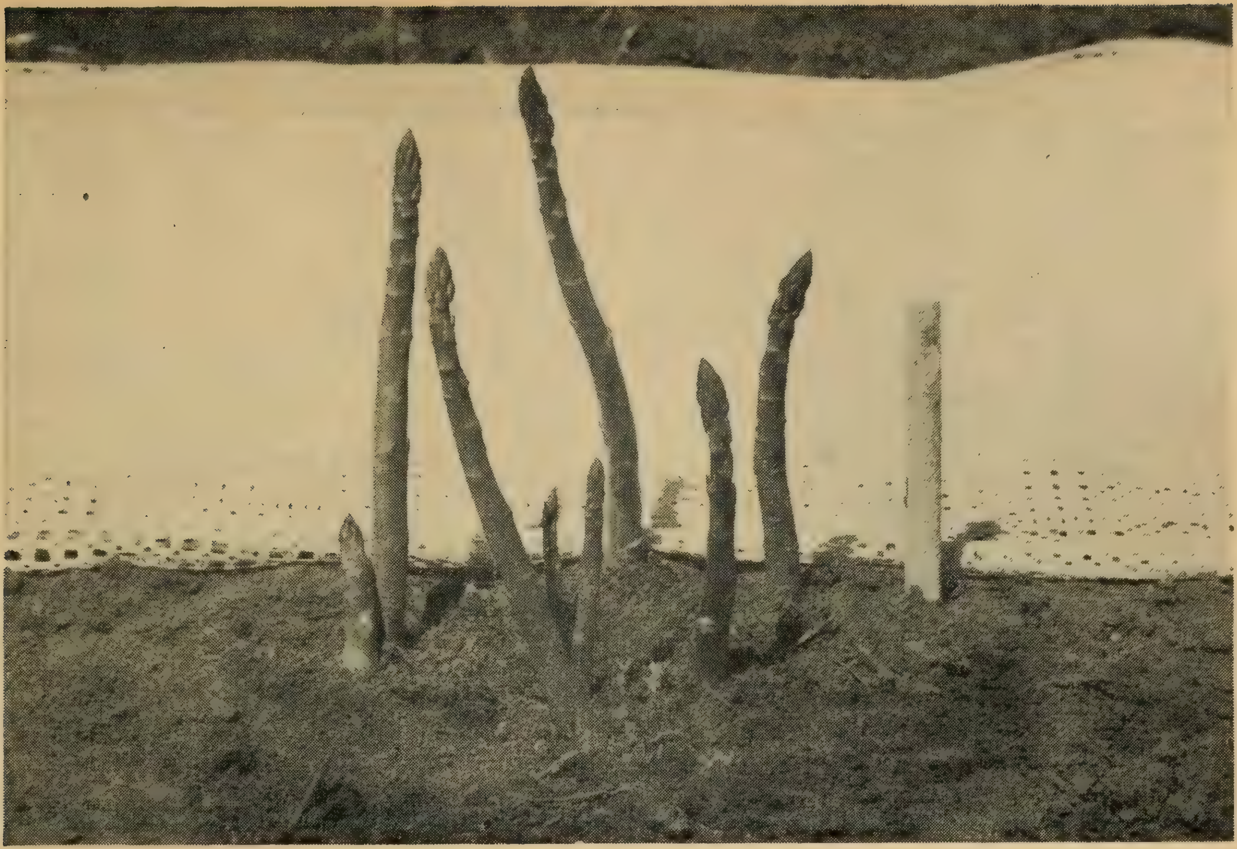

Fig. 1. Vineland 35 asparagus.

Green Pods (pole)

The pods of **Kentucky Wonder Green Pod** (Old Homestead) are peculiarly wrinkled, 7 to 9 inches long, and comparatively early for this group. It is a heavy yielder. **Rialto** is a white-seeded Kentucky Wonder type. It is resistant to powdery mildew, some forms of rust, and highly tolerant to bean mosaic. **Blue Lake,** a selection from White Creaseback, is fat oval, approaching round, in cross section. When the pods are picked at about half size the quality is excellent. When canned it is usually put up in whole lengths (asparagus style). There are at least three strains of Blue Lake, namely, Early, Late, and Black-seeded. One of the best late stocks is sold as Stringless Blue Lake B-5. **Decatur** received an All-America Silver Medal in 1942. It is highly resistant to common bean mosaic and certain forms of rust; its pods are round, practically stringless, and equal to those of Blue Lake in length.

Some other green pole garden beans are **Kentucky Wonder Rust Resistant, Dutch Caseknife, Scotia,** and **Lazy Wife.** Although **Delicious Giant** and **Oregon Giant** are high in quality, the green colour of the pods is strikingly marked with brownish purple or red.

Yellow Pods (pole)

Kentucky Wonder Wax and **Golden Cluster Wax** are the best known yellow-podded pole beans.

Purple Pods (pole)

Blue Victor has large, meaty, stringless, somewhat flat pods which are reddish-purple in colour. When the pods are cooked, the colour changes to a light green. It is an attractive novelty.

2. *Dwarf Bush, Kidney, or Snap Garden Beans*

The pods are cooked or processed when young or at the stage of maturity when they may rightly be called snap beans. This type, particularly the wax group, is popularly known as butter beans (this name is also used for an entirely different type).

A.—Green podded

1. *Pods flat**: Black Valentine, Stringless Black Valentine Oval Pod, Bountiful, Masterpiece, Plentiful (Black-seeded Bountiful), Streamliner (Granda or White-seeded Bountiful), Black Prince, Prince (Sutton Prince), Early Six Weeks, Fairmont, Long Island Longpod, Florida Belle, Princess of Artois.
2. *Pods round*: Stringless Red Valentine, Stringless Black Valentine, Round Pod Stringless Green Pod, Asgrow Stringless Green Pod (Tendergreen), Tenderlong, Giant Stringless Green Pod, Tenderpod, Full Measure, Longfellow, Commodore, Keystonian, Logan, Longreen, Fordhook Favorite, Ranger, Refugee Stringless Green Pod, Refugee 1000-1, Idaho Refugee, Medal Refugee, Sensation Refugee Nos. 1066 and 1071, U.S. Refugee 5, Rival, Tiny Green.

B.—Wax or yellow-podded

1. *Pods flat*: Bountiful Wax, Wardwell Kidney Wax, Stringless Kidney Wax, Currie Rustproof Wax, Davis White Wax, Unrivaled Wax, Topnotch Golden Wax, Surecrop, Hodson Wax, Pacer, Webber Wax (Crackerjack, Early Wonder Wax), Cherokee Wax.
2. *Pods round*: Challenge Wax, Round Pod Kidney Wax (Brittle Wax), Pencil Pod Wax, Prolific Black Wax, Refugee Wax, Cooper, Royal Purple Wax, Sensation Wax, Kinghorn Special, Puregold Wax.

* Beans that are heart-shaped or oval in cross-section are classed with the round group, and any pod with a diameter in one direction less than 80 percent of the diameter at right angles to it is considered flat.

Other things being equal, consumers prefer round-podded to flat-podded types. However, the market gardener often does not grow varieties of the best quality. There are at least two reasons for this. For maximum profit he must consider the early market and the flat-podded types provide some of the earliest varieties. Although not disease-resistant in the true sense of the word, yet the flat-podded types commonly stand up better under disease, drought, and in marketing than do the later round-podded varieties. For these reasons, the early, hardy, flat-podded varieties such as **Plentiful** and **Bountiful** are often used by market gardeners.

Green Pods (bush)

The green-podded type is probably generally preferred to the wax, since the latter readily show spots that are suggestive of maturity and inferior quality (though the beans may be in perfect condition). But, unblemished wax beans are often the first choice because of their appearance and quality.

Asgrow Stringless Green Pod (Tendergreen, New Stringless Green Pod), which is round-podded, is fairly early and useful for market, canning, and freezing. It is tolerant to bacterial blight. A larger-podded form is **Tenderlong,** which is also slightly darker green in colour. The **Stringless Green Pod** group is the most popular of all green-podded types for canning, in the home garden, and to a considerable extent in market gardens.

Full Measure is only of average merit but has maintained a place for many years and is useful for commercial canning of cut beans.

The European type of bush bean has long been the envy of breeders in the United States and Canada, because of the comparatively tall,

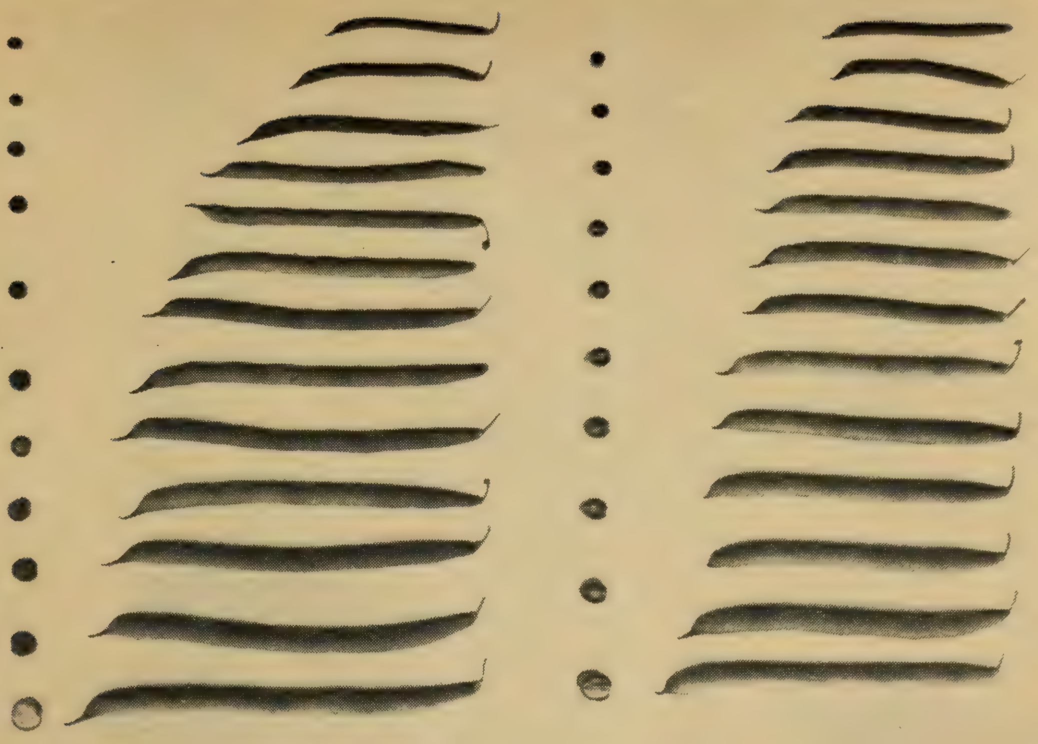

Fig. 2. Blue Lake pole bean.

vigorous, disease-resistant plants with long, attractive flat, almost straight pods. When it is grown on this continent the pods are fibrous and heavily stringed, but, under European conditions, especially in the British Isles, these long-podded types are superior in size, quality, and appearance to the round-podded American bush beans. The best known European variety in Canada is probably **Masterpiece,** but the most outstanding of the European sorts here is **Black Prince.** It is appropriately named as the plant is tall with healthy, dark-green foliage and long (sometimes 11 inches), almost straight, dark-green, attractive pods which contain jet black seeds. Hybridists on the American continent have, step by step, been working towards types whose pods would compare in appearance with European stocks.

The two stocks on this continent which are closest to the European type are the forms of **Stringless Black Valentine,** and the disease resistant **Florida Belle,** but these varieties are rather late except in the warmest sections of Ontario. A break in the right direction for Ontario growers came around 1941 with the introduction of **Long Island Longpod** (Prince x World's Fair) and **Streamliner.** These have long, straight, flat, stringless but fibrous pods, borne on vigorous, healthy plants. Streamliner seems to be one of the best adapted of the long-podded sorts for Ontario.

Meanwhile, round, stringless, green-podded varieties are undergoing modification in which their pods are becoming longer and straighter. **Keystonian** was introduced in 1944. Its pods are longer and more attractive than those of Tendergreen. **Logan** (Stringless Black Valentine x U.S. No. 5 Refugee) was also introduced in 1944. It is similar to but more disease resistant than Keystonian, and is adapted to the warmer areas of Ontario. **Longreen** received an All-America award in 1946. Its pods are straight, dark-green, round, stringless, fibreless, and about 6 inches long. It is superior in appearance to Keystonian and is early enough to succeed in southern Ontario. It is of high table quality and is splendid for home use, as well as canning, shipping, and market gardening.

Refugee, in its many forms, is a late sort for canning, but is not advised for market because of the small size and light green pods. Certain stocks, such as the Medal and Idaho strains, Sensation Refugee 1066 and 1071, and U.S. Refugee No. 5 are resistant to forms of mosaic. **Ranger,** which won an All-America award in 1947, is said to be resistant to mosaic, mildew, and all forms of rust.

Princess of Artois is the earliest bean. The pods are small and edible while young. The dry white seeds can be used for baking. It is valuable in short-season areas. **Tiny Green** is so small podded that it need not be cut or split in being prepared for canning or cooking. The only work required is to snip off the pod stems and tips. The small pod size is not combined with extreme earliness. Seeds white.

Commodore is a novelty in that it has pole bean pods on a bush bean plant. **Rival** is resistant or tolerant to most bean diseases, and is suitable as a canning bean, for market, shipping, and the home garden.

Wax Pods (bush)

Almost any flat-podded wax variety may be sold on the market as **Bountiful Wax,** but **Webber Wax** and **Surecrop Black Wax** frequently are sold under this name. **Hodson Wax** is a late flat-podded variety that is rather stringy and tough but it is striking in appearance and useful for shipping. **Cherokee Wax,** which was developed by the U. S. Department of Agriculture, is a promising variety. It is productive, useful for canning, and apparently tolerant of common bean diseases. **Davis White Wax** is notably even in maturing and with a short picking period. The dry seeds being white makes this a good dual-purpose home-garden variety for baked beans and for snap pods, though the quality is only fair. The stringless form is widely grown owing to its earliness, beautiful pods, heavy yield, and good shipping qualities.

For the early market and in home gardens, **Unrivalled Wax, Surecrop Black Wax,** and **Topnotch Golden Wax** are widely grown.

In the round wax-podded type, **Round Pod Kidney Wax** (Brittle Wax) is a widely planted midseason, attractive, high quality variety valuable for canning and one of the best home and market garden wax beans. **Sensation Wax** No. 1 and No. 2 have been developed for whole bean canning and No. 3 for cut bean canning. **Kinghorn Special** is a white-seeded strain of Round Pod Kidney Wax. **Pencil Pod Wax** is of very high quality, but the tendency of the pods to curve has kept it from being a popular garden or shipping bean, and the black seed is a drawback for canning. **Prolific Black Wax** resembles Pencil Pod Black Wax. **Pacer** is the earliest wax bean so far tested. **Puregold Wax** was awarded an All-America bronze medal in 1947. The bush is about 13 inches high with dark-green foliage, and is resistant to common bean mosaic. The pod is slim, round, stringless, golden yellow, 5½ to 6 inches long, comparatively free from "green ends"; slightly earlier than Brittle Wax. Adapted to market and home culture and to whole bean or cut bean pack.

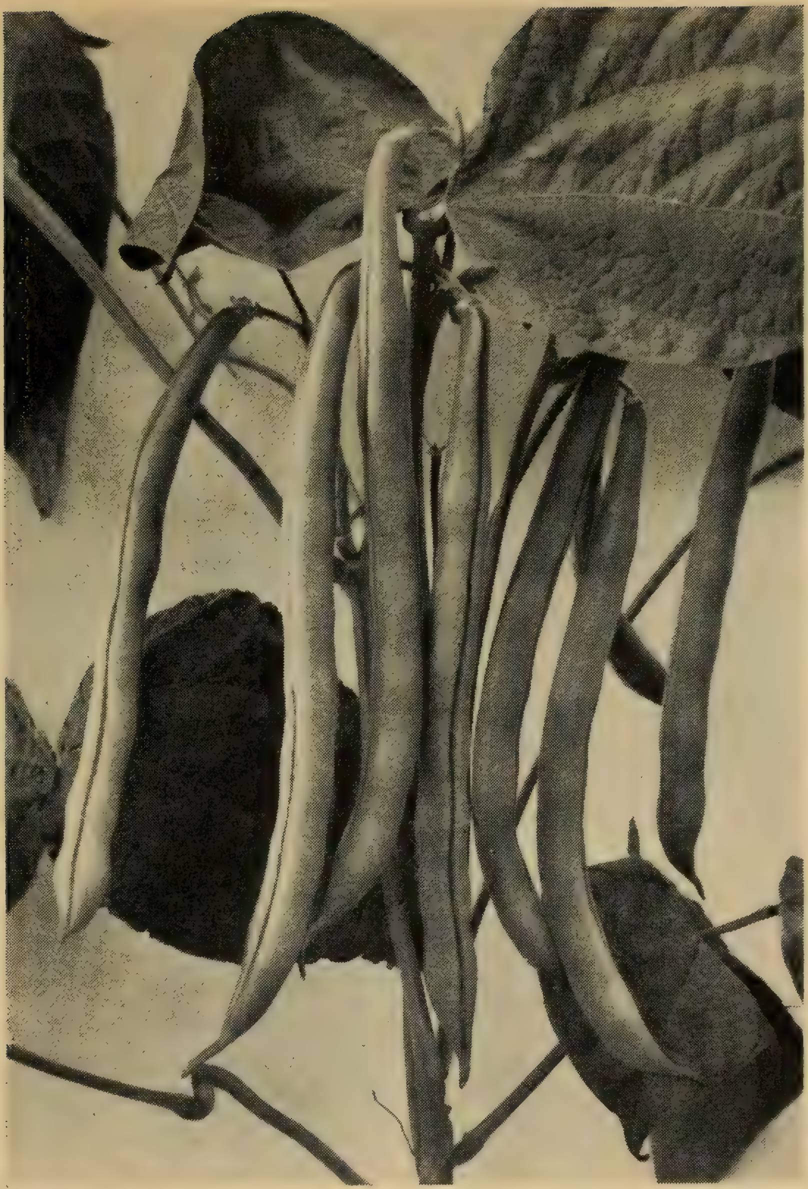

Fig. 3. Longreen bush bean.

For canning, certain companies place the emphasis on varieties with oval pods. These are often heavier yielding, more vigorous, and more disease resistant than round-podded sorts. It is now known that cool weather tends to make round-podded varieties flatter in shape. It may be that eastern and central Ontario are in a geographic belt which is more suitable to the production of oval varieties than round-podded ones. In this connection, it is significant that seedsmen sometimes list certain stocks e.g., Black Valentine, in flat, oval, and round strains. For canners and others wishing to try an excellent oval type the variety **Stringless Kidney Wax** is suggested.

3. *Shell or Dry Beans*

These are a type of bush bean developed for the production of seed to be used dry. The pods are harvested when they are quite dry, and then threshed for winter use. The seeds are usually a solid white, red, brown, yellow, or black.

The **Navy** or **White Navy** bean is sold under many names. It is small, white-seeded and much used for cooking and baking. **Michelite** is an improved form of the Navy bean. **Robust** is a comparatively late strain. At times it has shown resistance to mosaic but in Ontario over a prolonged period no form of the Navy bean has shown immunity to disease.

Great Northern is productive, only fair in quality, and the seeds resemble large, rather lengthened Navy beans. The Idaho Station has introduced four selections of Great Northern which are said to show these features: No. 123—large, white, resistant to common mosaic and tolerant to curly top; No. 59—largest sized Great Northern, resistant to common mosaic and curly top; No. 15—large, resistant to common mosaic and curly top, and can be grown in areas where curly top damage is usually severe in other Great Northern strains. All four selections are excellent cooking beans.

Some other shell beans are **Red Kidney, White Kidney, White Marrowfat,** and **Canadian Wonder.** The earliest white-seeded commercial type is **Burbank** or **Gohn Rainy River.** Still earlier is the coloured **Norwegian Brown. Swedish Brown** is generally in season with Burbank.

4. *Runner Bean*

The runner bean may grow 12 feet or more tall. Chiefly esteemed in Ontario as an ornamental climber for porches and fences because of the rapid growth and large, scarlet flowers on long stems, but is a popular edible type of bean in England. The snap pods are stringy and fibrous, except when very young or quickly grown. The cotyledons (seed leaves) remain below ground when the seed germinates thus differing from other types of bean. The root is conspicuously thickened. **Scarlet Runner, Prizewinner,** and **Streamline** are leading varieties.

5. *Broad Bean*

The broad bean resembles a huge pea or lima bean more than an ordinary bean and is used like a green pea. There is a felt-like padding inside the pod between the pod wall and the seed. At maturity the spongy felt surrounding the seed disappears. The broad bean, which is the bean of history, has long been popular in Europe, but is of little economic importance in Ontario although it is grown in many home gardens especially in the short-season districts.

A.—Longpod: Pods long (5 to 9 inches), contain 4 to 7 seeds.
  1. White-seeded.
    (a) Eye white: Victoria, Long-Pod, Threefold White.
    (b) Eye dark: Hangdown, Seville, Early Long-Pod White Seeded, Aquadulce, Champion, Eclipse, Monarch, Erdington Gem.
  2. Green-seeded: Green Leviathan, Mammoth Green Long-Pod, Early Long-Pod Green Seeded, Olympic, Green Masterpiece.

B.—Windsor: Pods short, contain 3 to 4 seeds.
  1. White-seeded.
    (a) Eye white: Victory, Early White-eyed.
    (b) Eye dark: Broad Windsor, Taylor Windsor, Harlington Windsor.
  2. Green-seeded: Green Windsor.

C.—Dwarf fan-podded: Very short internodes; small, dark-green foliage; 15 inches tall; short, narrow pods arranged in fan form; seeds small; 2 to 3 seeds.
  1. White-seeded: Early Magazan, Dwarf White Fan.
  2. Green-seeded: Green Gem.

Broad Windsor and **Hangdown** are the most widely grown varieties but stocks from the British Isles make possible a wider choice.

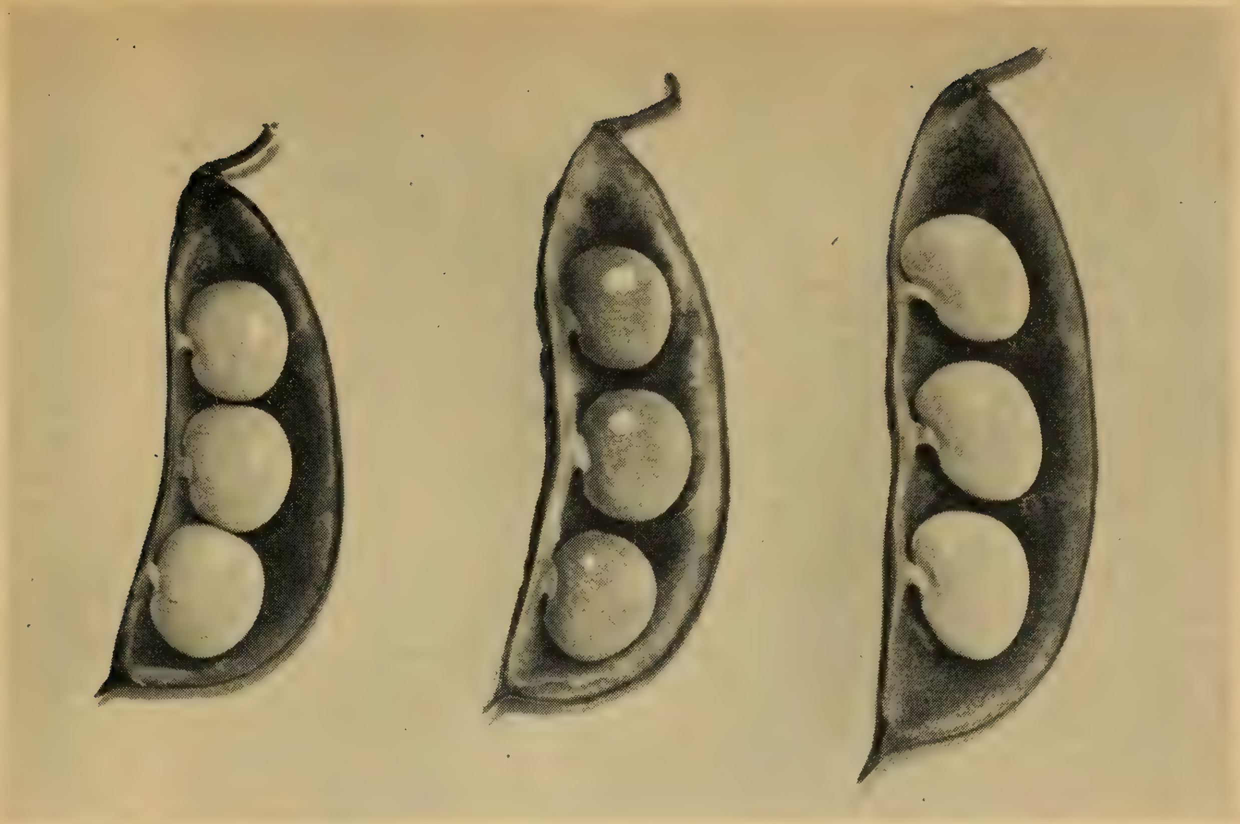

Fig. 4. Bush lima beans. *Left to right:* Baby Potato, Cangreen, Henderson Bush.

6. Horticultural Bean (Cranberry Bean)

In the green-shell and later stages the pods are brilliantly splashed with red. Used as snap buttered beans, and, as shelled beans both in the green-shell and dry-shell stage as baked beans or in soup. **London Horticultural, Mammoth Horticultural, Italian,** and **Red Cranberry** are pole varieties. **French Horticultural** and **Dwarf Horticultural,** also known as Dwarf Cherry, Ruby, or Speckled Cranberry, are dwarf, as is **Low's Champion,** which sometimes is sold in bush form as Maryland Thick-seeded or Red Cranberry.

7. Lima Bean

The botanical differences between lima and common beans are not great, but the two types are not cross-compatible. The presence of the glucoside linamarin, the result of two enzymes imparting the characteristic lima-bean flavour, is found in no other bean. The flower bracts are small, inconspicuous, lanceolate, and pointed in limas, and large, conspicuous, and oval in common beans. The seeds are the "butter bean" of England. Lima beans can be harvested as green limas when they have attained their maximum size but before they have started to turn white. Those that are not used in this stage can be allowed to mature on the plant and used as dry shell beans.

A.—Pole.

1. Large-seeded: Challenger, King of the Garden, Detroit Mammoth, Ideal.
2. Small-seeded: Small White Lima (Carolina or Sieva), Florida Butter, Willow Leaf, Wood's Improved.

B.—Dwarf.

1. Large-seeded: Burpee Improved Bush, Early Market, Fordhook Bush (Potato Lima), Fordhook 242, Concentrated Fordhook, Baby Potato, Baby Potato Early.
2. Small-seeded: Henderson Bush (Baby Lima), Clark's Bush, Cangreen (Thorogreen, or Green Seeded Henderson), Wood's Prolific, Peerless.

Pole lima beans are seldom grown in Ontario but for those who wish to try them **Challenger** is suggested.

In the case of dwarf lima beans, the dry seeds of **Burpee Improved Bush** are flat, large, and greenish white. **Early Market** is not thick-seeded, but is comparatively early and of a good green colour. **Fordhook Bush** (Potato Lima) produces green-shell beans that are large, very plump, and of high quality, and dry-shell beans that are white. **Fordhook 242** is somewhat more productive than Fordhook Bush, and **Concentrated Fordhook** ripens a few days earlier than Fordhook Bush.

Henderson Bush (Baby Lima) is popular for canning; green-shell beans small, flat, splendid quality; dry beans white; this is the bush form of **Small White Lima** (Carolina or Sieva). **Cangreen** resembles Henderson Bush but at the processing stage the beans are green. **Clark Bush** resembles Henderson Bush but is distinguished by its freedom from white beans at all harvesting stages, and is of great value to processors through the reduction of labour on the picking belt; the dry seeds are pale green. The seed of **Baby Potato** is shorter and thicker than that of Henderson Bush and is adapted for produce markets, canning, and freezing. **Baby Potato Early** is a few days to a week earlier. **Peerless** won an All-America award for 1948 introduction. Advance notice states that it is heat resistant and is especially adapted to processing as well as garden use. It may succeed in Ontario only on the very warmest sites.

8. *Asparagus, Yard-Long, or Cuban Bean*

The Cuban bean is a novelty pole bean. The slender (¼ inch) pods may grow 10 to 20 inches long.

9. *Edible Soybean*

Edible soybean plants grow 1½ to 2 feet tall. The pods are hairy and blunt, contain 3 to 4 seeds, and are picked when well filled but still green. The seeds may be shelled out of the green pods by hand or they may be put through the regular pea-vining machine. The edible soybean is used, in green form, as a vegetable, in salads, and canned; and, in dried form, baked, boiled, salted, in sauces, as cooking oil, and in numerous other ways. Dry soybeans are cooked like ordinary dry beans. The soybean is one of the most nutritious of all plant products. **Kabott** and **Bansei** are the leading varieties, but **Agate** is more suitable for short-season districts. **Sioux** is the earliest soybean so far tried in Canada. **Giant Green** and **Mendota** are worthy of trial on warm sites throughout central and western Ontario.

BEET

The variation that occurs in shape of individual roots within a strain or variety of beets is due both to hereditary and to environmental factors. It varies with the stage of growth (age and size) at which it is observed. In round varieties, the early stages involve an increase in diameter in relation to depth. This increase is greatest near the top of the root at the beginning and progresses toward the taproot. Thus, round roots are successively long top shaped, short top shaped, ovate, and round with increased age and diameter.

A.—Flat. Flat Egyptian.

B.—Short-top-shaped. Flattened at top and bottom with rounded sides to square or rounded shoulder and conical or tapered base: Crosby Egyptian, Light Red Crosby.

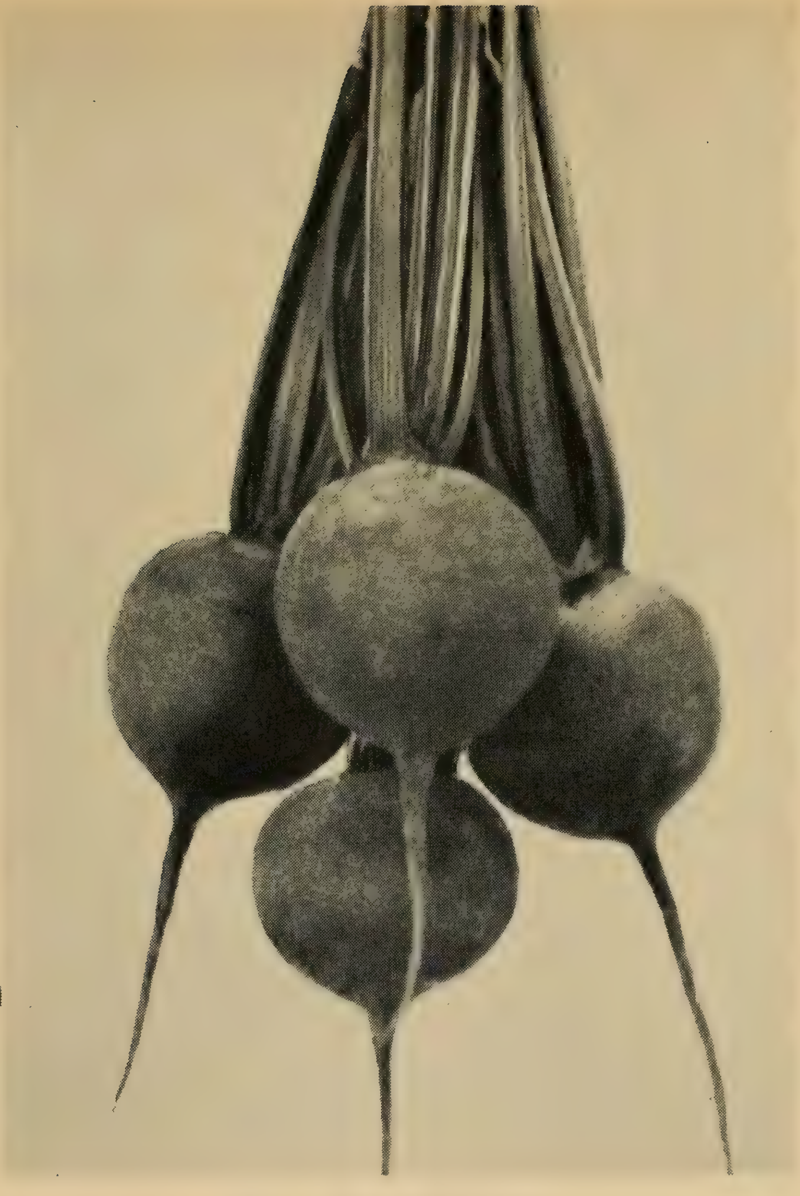

Fig. 5. Morse Detroit beet.

C.—Deep oblate to round. Early Wonder, Green Top Early Wonder, Asgrow Wonder, Morse Detroit, Ohio Canner.

D.—Globular to oval. Detroit Dark Red, Good for All, Perfected Detroit, Crimson Globe, Green Top Bunching, Asgrow Canner, Crimson King.

E.—Half-long. Half Long Blood.

F.—Long. Long Dark Blood.

Detroit Dark Red is the outstanding main-crop beet handled by most seedsmen, and is the chief variety for canning or sliced beet because it combines desirable size with dark colour and high quality. This variety is the most popular in Ontario for storage. It is widely grown by market growers for bunching and topping. Detroit Dark Red No. 6 and No. 16 are grown as registered stock by the members of the Canadian Seed Growers' Association; No. 6 is a large size strain for the farm garden, and the latter is a small type valuable for bunching. **Morse Detroit** produces smaller foliage, flatter roots, darker purplish-red skin, and slightly more purple flesh than Detroit Dark Red. The roots become round at a smaller diameter and are, therefore, somewhat more useful for canning whole, but they are not so valuable for diced or sliced beets.

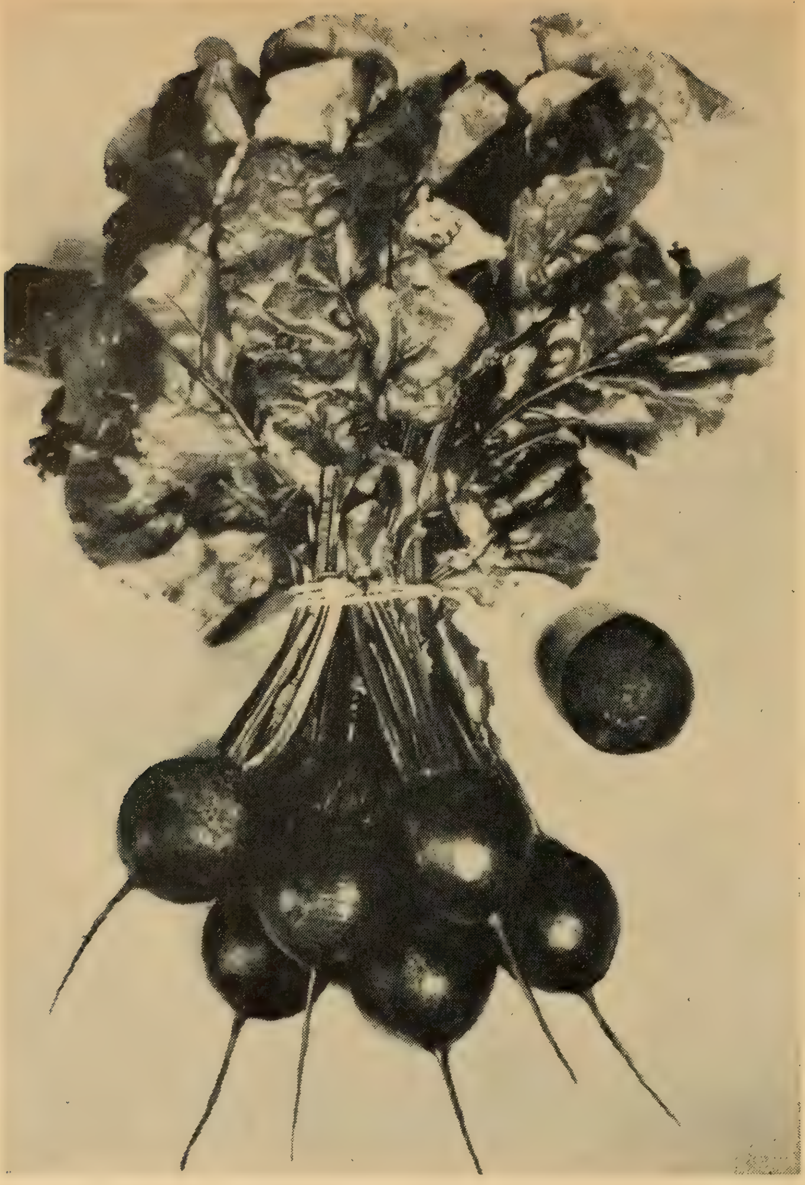

Fig. 6. Asgrow Canner beet.

Perfected Detroit, compared with Detroit Dark Red, is of larger neck and foliage, darker skin, less marked zoning, and shorter or more nearly round roots. **Good for All** is smaller than Detroit Dark Red, the leaves are narrower and smoother, and the flesh is with less zoning. **Ohio Canner** is uniformly dark red and is primarily a canning variety, as is **Asgrow Canner.** There are short-top and medium-top strains of Detroit Dark Red, the former being suited in a general way to shipping and canning and the latter to bunching. **Crimson King** develops large-sized, globular roots.

Flat Egyptian is not of the best quality or appearance but it is the earliest variety, and is the sort most used for transplanting. **Crosby Egyptian** is widely grown for early market and as a bunching beet for summer and fall use. It is not a good canner because the purple colour fades in processing, leaving pale or light-coloured zones in the product. **Asgrow Wonder** is of the same root shape and skin colour as **Crosby Egyptian,** but the neck and foliage are larger and the flesh is redder with less pronounced zoning. In **Light Red Crosby** the bright red colour of fresh-

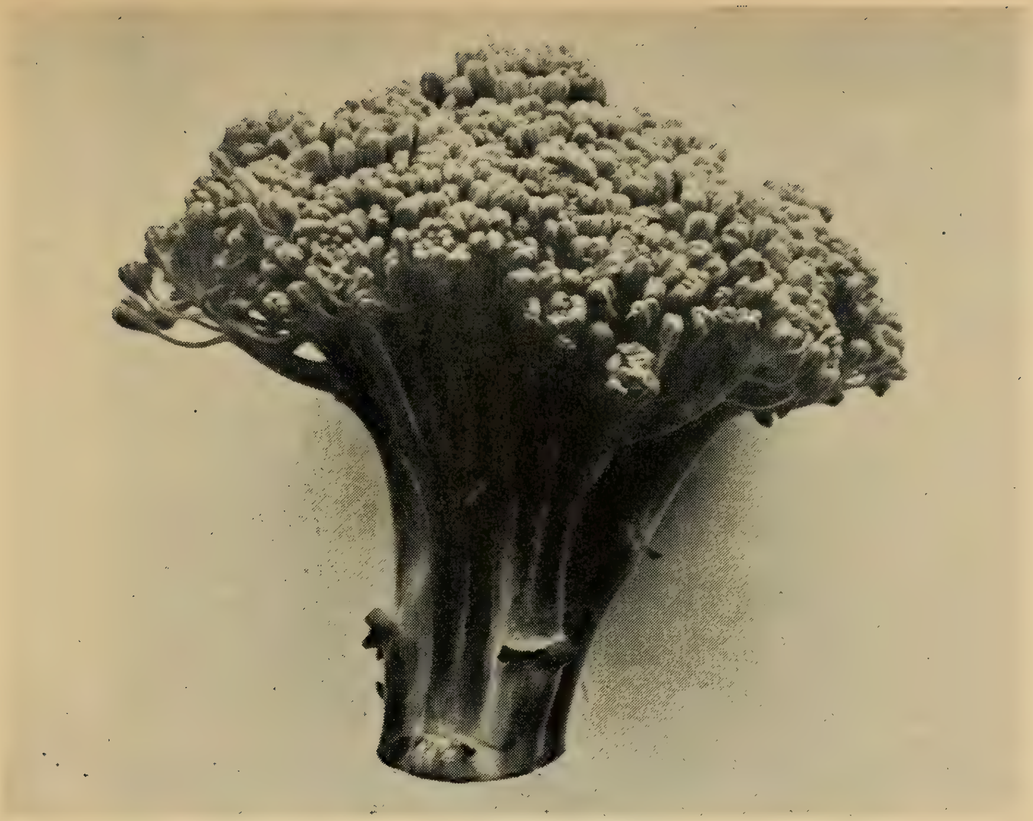

Fig. 7. Sprouting broccoli.

ly washed or moist roots is very attractive, but the colour of the cooked flesh is an unattractive light red or pink. In **Early Wonder,** because of the greater area of the smooth below-ground surface visible when it is bunched, the roots often seem lighter and brighter in colour than those of Crosby Egyptian, but, on the whole, it resembles dark strains of Crosby Egyptian.

The foliage of **Green Top Early Wonder** keeps its fresh appearance as the leaves do not turn red or bronze in cool weather, and so this variety shows merit for bunching. Likewise, **Green Top Bunching** shows promise for the fall bunching crop; its leaves do not turn red as quickly as those of most other varieties.

Long Dark Blood may grow 16 inches or so long. It is more popular for storage in Europe than on this continent.

BROCCOLI, SPROUTING

In sprouting broccoli, a main head is produced terminally on a fleshy, branching, elongated stalk or stem. Besides the terminal head, longer, more slender, and smaller heads appear laterally in the axils of the leaves. Though there are three classes of sprouting broccoli, namely, green, white, and purple, the green-coloured type is most popular.

De Cicco is the earliest strain. **Italian Green Sprouting Early** requires about 70 to 75 days before it is ready for use but is a higher yielder of better quality heads. **Propageno** produces large central heads but comparatively few side heads. The name **Calabrese** is of uncertain meaning and may refer to more than one strain, and, in fact, there are strains of Green Sprouting Early which vary with the seedsmen. The plant of **Texas Early** is small, not as vigorous as those of the regular commercial strains, but it produces large, firm, small-budded heads of excellent quality and appearance. **Freezers' Sprouting Green,** which was developed for commercial freezing, is dwarfer (15 to 24 inches tall), and earlier than older sorts. It forms a greater number of individual side heads rather than being concentrated into a central, larger head with fewer laterals. The heads average about 3 inches across, which is a desirable size for freezing. **Green Sprouting Medium** is about 3 weeks later than the early strains, but is too late for most districts.

Heading broccoli is discussed under late cauliflower.

BRUSSELS SPROUTS

The Brussels sprouts plant is the Tom Thumb of the cabbage family. The edible sprouts, about the size of a walnut, resemble miniature cabbages and are produced in the axils of the leaves along, and around, the main stalk. They develop progressively from the bottom upwards.

A.—Tall (over 25 inches). The plants grow 3 to 4½ feet high in some regions; the taller sorts commonly give a high percentage of loose, open sprouts which are inferior for storage: Amager Market, Danish Prize, Scrymger's Giant, Aigburth, Evesham, Bedford, Matchless.

B.—Intermediate or half dwarf (20-24 inches). Varieties of this type are the most widely grown: Long Island, Dalkeith, Half Dwarf, Paris Market, Catskill, Covent Garden.

C.—Dwarf (under 20 inches): Dwarf Perfection, Dwarf Gem.

Catskill is slightly earlier than others of its class, produces fewer soft sprouts at the base of the plant, and makes fewer unproductive plants. It is suggested for planting in place of **Long Island Improved,** which is now the most widely grown variety.

CABBAGE

Cabbage is grown for four distinct uses, namely for salads, boiling, pickling, and sauerkraut.

A.—Early. First to reach edible maturity, not a storage type; average weight of heads, 2 to 4 pounds.

1. Heads globular: Golden Acre, Green Acre, Vienna, Copenhagen Market, Dwarf Round Dutch, Racine Market, Marion Market.
2. Heads flat or drumhead—the term "drumhead" designates white, red, or savoy cabbages with heads that are broad but elliptical in cross section: Early Spring, Early June, Early Savoy, Dwarf Flat Dutch.
3. Heads pointed or conical: Jersey Wakefield, Jersey Queen.

B.—Intermediate or midseason.

1. White.
    a. Heads globular: Glory of Enkhuizen, Globe.
    b. Heads flat or drumhead: All Head Early, Succession.
    c. Heads pointed or conical: Charleston Wakefield, Winnigstadt.
2. Savoy. Leaves blistered, with little bloom: Early Dwarf Ulm.
3. Red (The colour which is most common and most preferred is nearly purple or reddish purple. Red cabbage is attractive for salad use and of distinct quality for pickling and certain culinary preparations): Earliest Round Red.

C.—Late. Latest to reach maturity; the best storage and sauerkraut varieties; average heads 4 to 6 pounds in weight, often more.

1. White.
    a. Heads globular: Danish Ballhead, Ferry Hollander, Penn State Ballhead, Wisconsin Hollander, Huguenot.
    b. Heads flat or drumhead: All Seasons, Late Flat Dutch, Surehead.
2. Savoy: Improved American Savoy, Chieftain.
3. Red.
    a. Heads globular: Round Red Dutch.
    b. Heads flat or drumhead: Mammoth Rock Red.

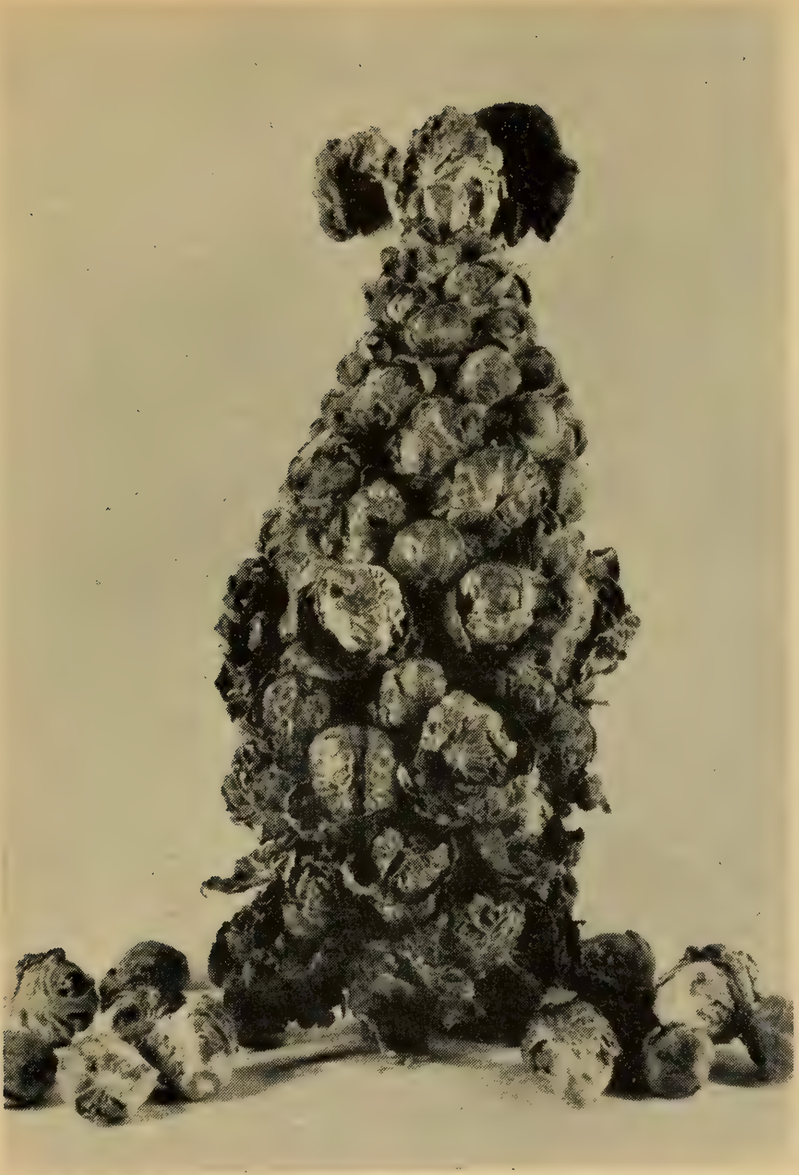

Fig. 8. Brussels sprouts.

Golden Acre is a leading early, globular cabbage. **Copenhagen Market** is slightly later and larger, as is **Green Acre. Jersey Wakefield** has a pointed head; Copenhagen Market and Golden Acre, at about the same season, yield a higher tonnage per acre, and their roundish heads are of better shape for packing. **Dwarf Round Dutch** makes a very hard head. **Glory of Enkhuizen** is a high-yielding, globular, early-midseason variety but is none too uniform. **Winnigstadt** is a hard-heading, early, conical cabbage, but is 2 weeks later than Golden Acre. It is more resistant to adverse weather than some other varieties and stands in the field comparatively long without bursting. **Vienna** is early, small, and non-splitting.

Ferry Hollander is a late, globular, variety for the fall harvest and for storage. **Danish Ballhead,** the chief late variety for home use, market garden, storage, and sauerkraut, may be classified into three strains: (a) short-stem; (b) middle-stem; and (c) tall-stem. The short-stem strains are somewhat earlier than the tall strains (a short stem for this variety may be long in comparison with those of other varieties). The head is

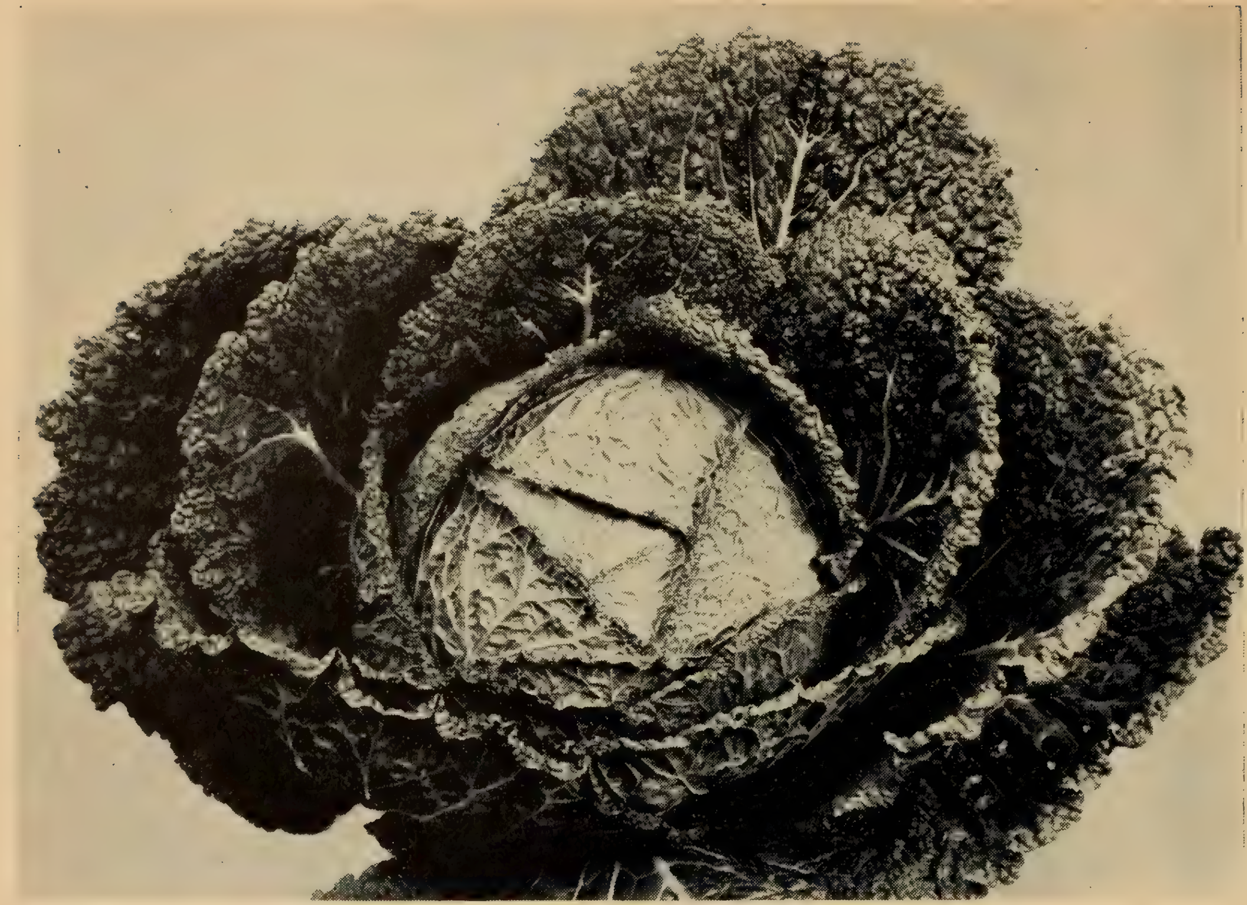

Fig. 9. Chieftain savoy cabbage.

almost globular. **Penn State Ballhead** corresponds to middle-stem Danish Ballhead in height and general appearance, but the heads are more nearly globular. **Huguenot** is too late for all but the warmest districts of Ontario and is not likely to give solid, uniform heads here; it was introduced as a cold-resistant type that would overwinter successfully in the Southern States.

In the late, flat type, **Late Flat Dutch** produces large to very large heads, is widely grown, but does not store any too well. **All Seasons** and **Surehead** are other flattish, main-crop-to-late, productive varieties.

Improved American Savoy long has been the standard savoy cabbage. **Chieftain** is an improved savoy.

Mammoth Rock Red (flat) and **Round Red Dutch** (globular) are leading late, red cabbages.

There is not a widespread need in Ontario for strains which are resistant to the yellows disease. However, once yellows is established on a particular piece of soil, the disease is likely to increase, even under a system of crop rotation. The following varieties are resistant to yellows but otherwise are not superior to the varieties shown in brackets from which they were developed: **Racine Market** (Early Copenhagen Market), **Marion Market, Resistant Detroit,** and **Iacope** (Copenhagen Market). **Jersey Queen** (Jersey Wakefield). **All Head Select** (All Head Early). **Wisconsin All Seasons** (All Seasons), **Globe** (Glory of Enkhuizen), **Wisconsin Ballhead** (Danish Ballhead), **Wisconsin Hollander No.** 8 (Hollander), and Red Hollander (Red Cabbage). **Bugner** is a large, late, resistant variety useful for market, storage, and sauerkraut.

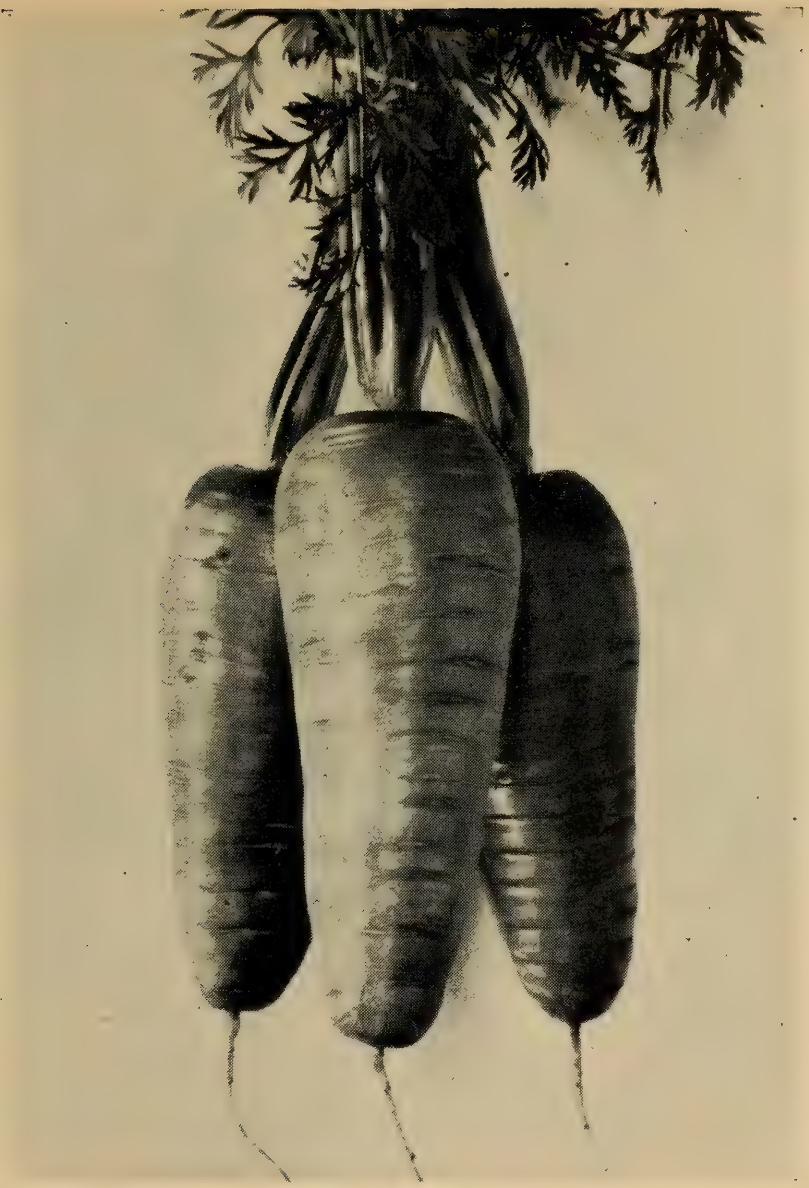

Fig. 10. Red Core Chantenay carrot.

CANTALOUPE, see MUSKMELON

CARROT

The colour desired by home consumers, the general market, and canners is a deep orange-red in all parts of the root. The root changes from a yellowish white, when very young, to whitish yellow, light yellow, dark yellow, orange, or orange-red, as a result of the accumulation of carotene in varying intensities of yellow. In fairly uniform strains the larger roots usually have a higher concentration of carotene than smaller roots of the same age. In mixed stocks the larger roots are likely to be lighter coloured, especially if the seed was produced near larger, lighter-coloured varieties with which the female parent could cross.

A.—Long-rooted. Mature roots may be 10 inches long or more and taper to a distinctly long-drawn-out point. They penetrate deeply; hence the plants may get more moisture, once established, than shorter-rooted kinds. This may be important in dry seasons in certain areas, but the feeding roots extend much deeper than the edible part of the root and the length of this latter portion, whether long, half-long, or short, is not actually the significant factor. Does best on a comparatively light soil.

1. Gradually tapering; fair to medium quality.
    - (a) Fair quality (stock varieties): Long Orange.
    - (b) Medium quality: Intermediate, St. Valery.
2. Somewhat thickened root tip; high quality (bred for bunching and gradually tapering at that stage): Morse Bunching, Streamliner.

B.—Half-long-rooted. Length usually less than 8 inches and never more than four times the widest diameter. Includes the leading home and market-garden varieties.

1. Root cylindrical to tip or with tapering shoulder; thin skin; highest quality.
    - (a) Shoulder tapering: Nantes, Rubicon, Strong Topped Nantes.
    - (b) Shoulder straight: Touchon.
2. Root tapering with blunt or semi-blunt tip; thick skin; good quality.
    - (a) Blunt root tip: Amsterdam, Chantenay, Red Cored Chantenay, Long Chantenay, Nancy.
    - (b) Semi-blunt root tip: Air Liner, Danvers, Hutchinson, Short Top Shipper, Imperator, Tendersweet, Supreme Half Long.

C.—Short, stump-rooted. Useful on heavy soils where pulling is difficult with longer sorts, on shallow soils, and for forcing.

1. Heart-shaped: Oxheart (Guerande).
2. Oval: Early Scarlet Horn.
3. Round: French Forcing.

Chantenay, particularly Red Cored Chantenay, is a leader for general planting, stores well, and is used extensively in canning for whole pack and dicing. **Long Chantenay** is longer and more slender and is useful for early bunching and as a topped variety for storage; in shape, it bears little resemblance to the original Chantenay. The longer **Morse Bunching,** and **Streamliner,** now the leading bunching varieties because they have been planted extensively in shipping areas, have not monopolized the bunching trade because they are not so early as could be desired in Ontario.

Nantes, the so-called "coreless" carrot, ranks first in quality but has a weak, brittle top which makes pulling difficult and detracts from its value for bunching. The straight sides of the roots are well adapted to commercial canning processes where blocky roots are desired, as much waste that occurs with abruptly tapering roots is eliminated. It does not keep quite as well as Chantenay because of its thin skin and fine texture. A strong topped strain is advised when Nantes type is desired for bunching. A home garden strain of Nantes is found in **Nancy.** This variety is intermediate between Nantes and Chantenay. It is more rugged, and still with good root colour and a small core.

Imperator received an All-America Silver Medal for 1933, and has assumed a prominent place among half-long varieties for both bunch and topped purposes. **Air Liner** resembles a short, stout Imperator. The tops are short, dark green, and strong. The variety is valuable for shipping.

Danvers is a market-garden variety with a stronger plant than Chantenay and the root tapers more to the point. An improved strain of Danvers is **Supreme Half Long.** It is longer than Danvers and with better interior colour. It is especially valuable on marsh land when a long slim type is desired. **Hutchinson** is a large sized strain of Danvers. It is grown for winter storage. On rich land, because of its size it is very productive. In the past its large roots have tended to be coarse, but

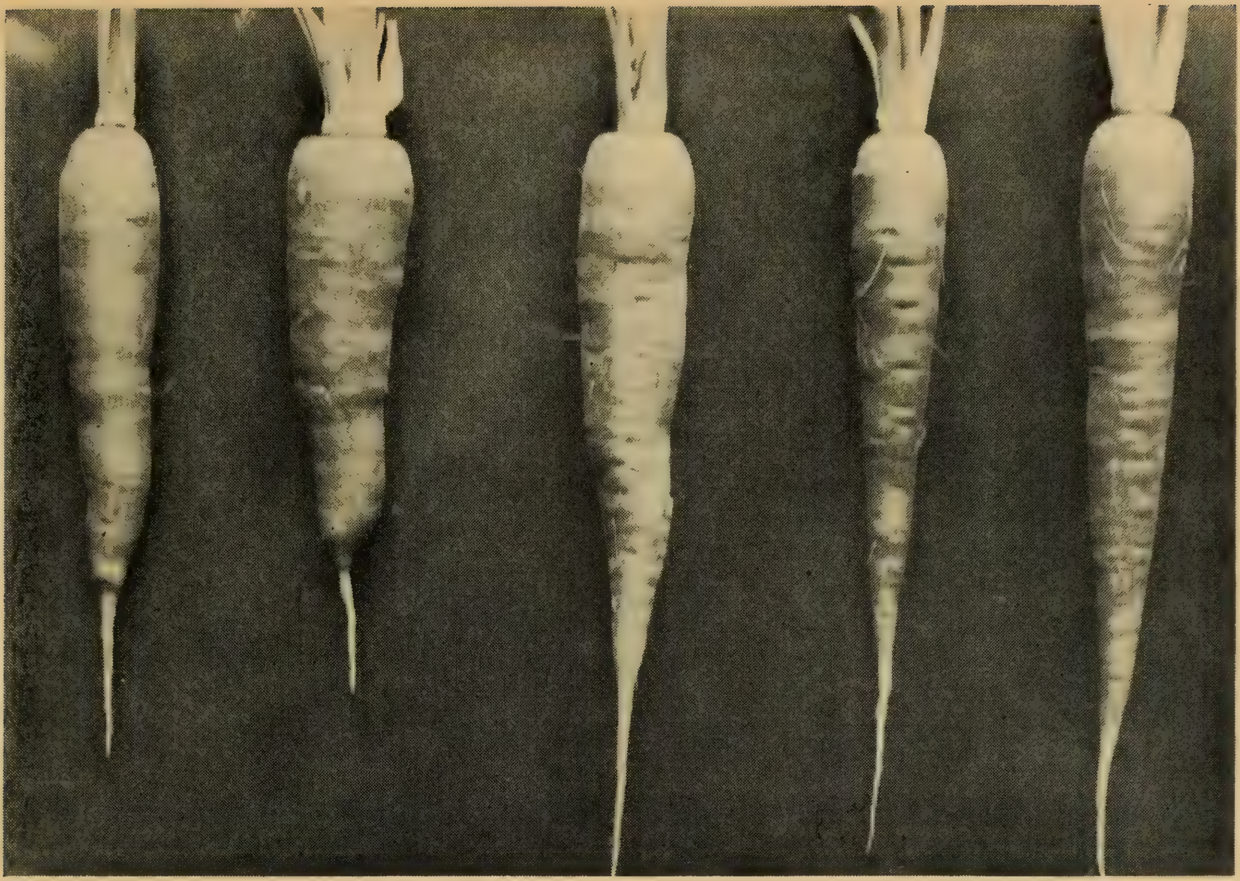

Fig. 11. Carrots at bunching stage. *Left to right:* Nantes, Chantenay, Imperator, Morse Bunching, Streamliner.

there are now improved strains available. Resistant to *Cercospora leaf spot.*

Intermediate and **St. Valery** are not grown to any extent in Ontario. They are of excellent quality under the climatic conditions of the British Isles, but under Ontario conditions the roots become too coarse to find favour.

Oxheart, Early Scarlet Horn, and **French Forcing** are too small and short for commercial bunching.

The three leading varieties on marsh land are Nantes, Imperator, and Supreme Half Long. A selected long strain of **Amsterdam Coreless** is showing promise for bunching and for the bulk crop on marsh land.

CAULIFLOWER

Seedsmen usually list fewer varieties of cauliflower than of a number of other vegetables. It is not easy to distinguish between varieties. Differences between strains of a certain variety are often as great as, or greater than, differences between two so-called varieties. Persistent endeavour should be made to secure seed of a well-bred and well-selected strain, for perhaps no other single factor affects successful culture as much as this one.

Early Cauliflower Varieties

The early varieties mature more rapidly and also differ in certain characteristics from late varieties. Early varieties planted late usually produce a later and better crop than late varieties planted early. If seed is planted periodically, early-type varieties will provide heads for early, midseason, and late use.

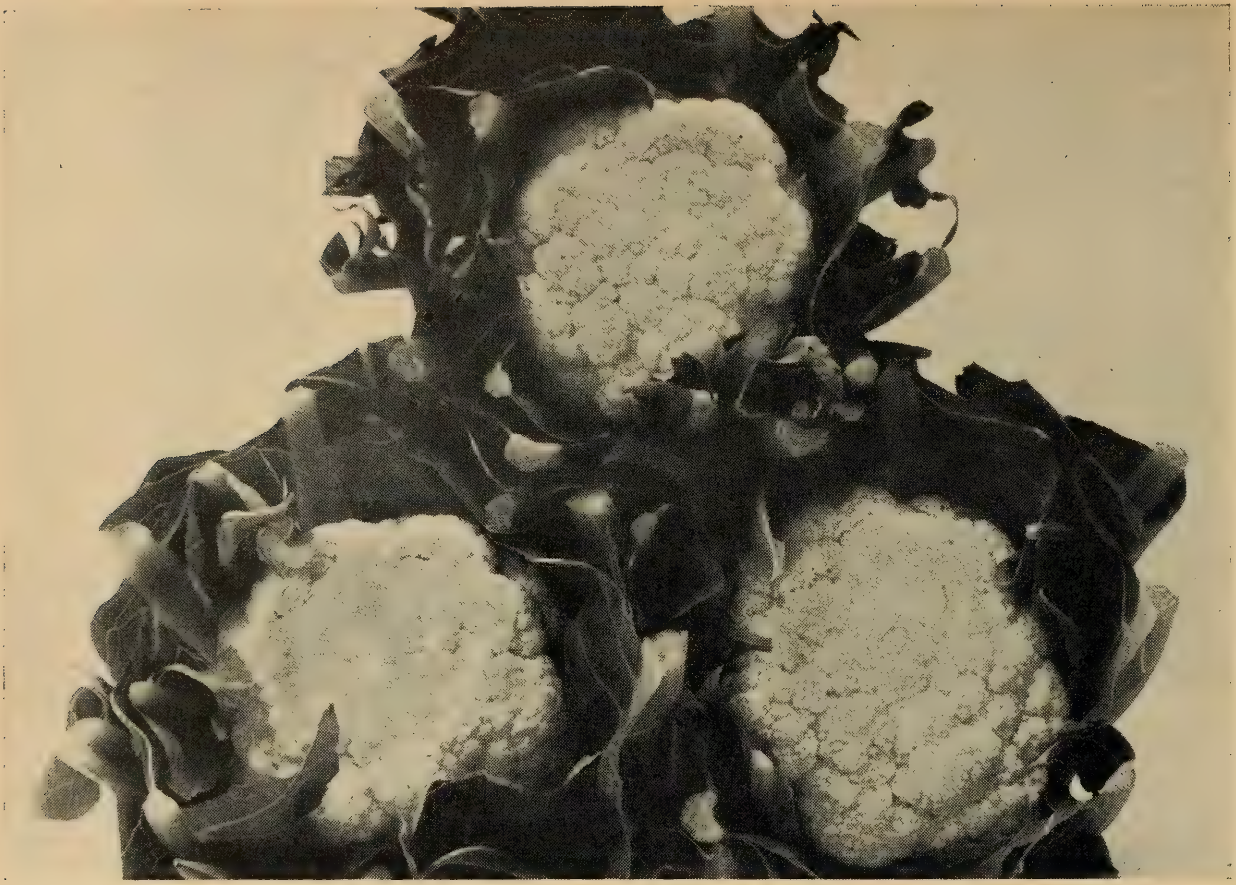

Fig. 12. Snowball "X" cauliflower.

Characteristics typical of early varieties are these: early maturity; dwarf habit of growth; inadequate protection of the curd because of sparse foliage (artificial protection is necessary for pure white or blanched heads); pale green leaves; well-rounded heads with a fine, closely formed curd of an attractive white colour when blanched; and excellent quality. Each head commonly weighs 1½ to 2 pounds.

During the war, the supply of European seed was cut off. It is anticipated that when this supply again becomes available marked changes will occur in cauliflower varieties and strains.

Erfurt is a dependable, outstanding variety for general use, and has long been a leader for home and market gardens. The name has largely been supplanted on this continent by **Snowball,** which is probably the most widely grown strain in northern regions. **Super Snowball** is also early and in fact is often earlier than many strains of Snowball. The heads are comparatively large but not deep. It has been a favourite with pickling factories and market gardeners. **Early Snowball "A"** is an early-maturing strain from American-grown seed.

Snowdrift (White Mountain) is a leading main-crop variety and is somewhat more vigorous than the earlier kinds. **Snowball "X"** is an American-grown strain of Snowdrift main-crop type. **Codania** and **Perfection** are strains of Snowball from Canadian-grown seed stocks. These at their best are deep and solid with a good percentage of heads well protected by leaves. They are vigorous and seem to stand up under rather adverse conditions better than most other types.

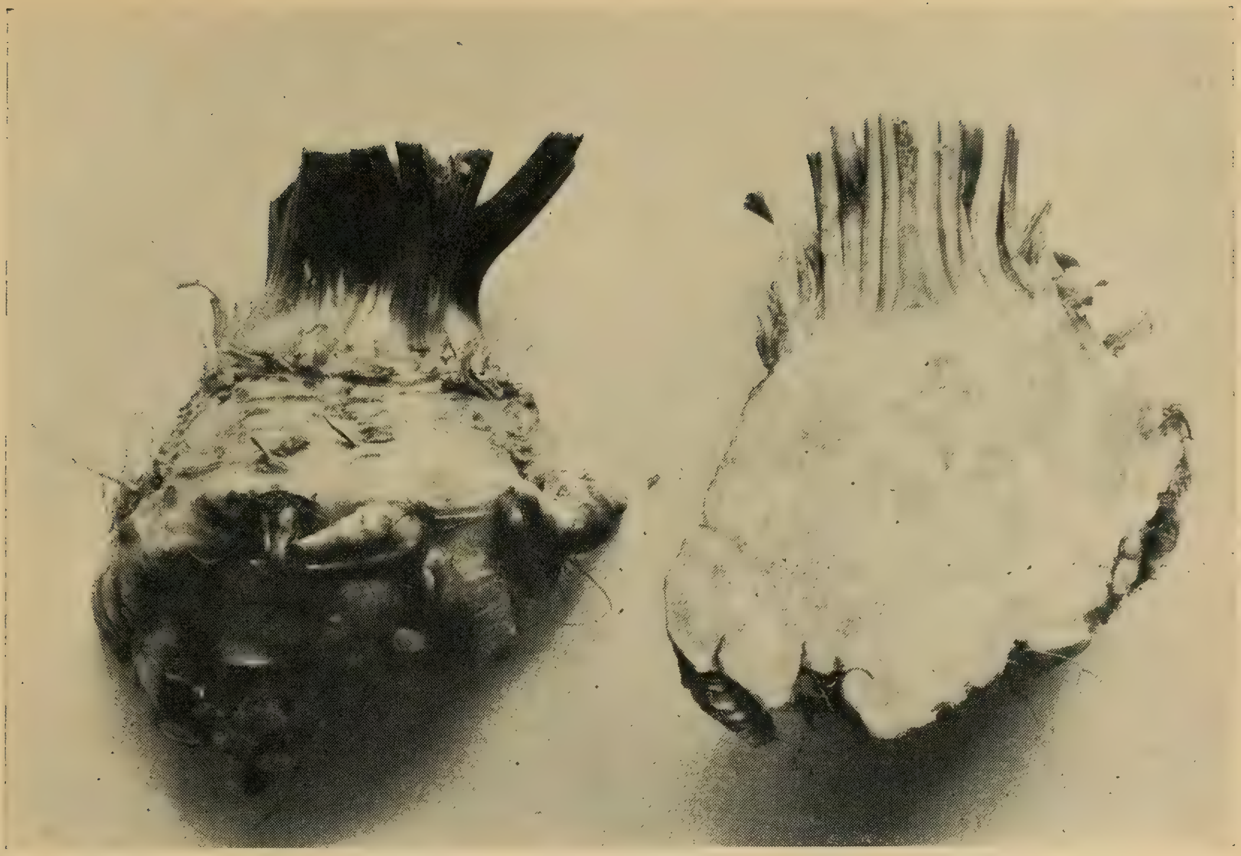

Fig. 13. *Left:* Celeriac. *Right:* Root cut through to show interior.

Catalogues often state that the **Danamerica** strain of Snowball and the **Danish Dry Weather** will stand up better under dry weather. This is true to a certain extent, but better success is usually obtained from earlier sorts which form their heads before the heat of summer commences.

Late Cauliflower Varieties

The late varieties (including heading broccoli) are larger growing and are not so well adapted to usual culture in northern areas as the earlier sorts. They are "a little too long in the leg," i.e., the head is produced relatively high off the ground on a long stem. **Autumn Giant** and **Large Algiers** are two of the older late cauliflowers.

There are purple as well as white cauliflower varieties. The purple varieties are comparatively late. The heads do not require blanching like the white type and the flavour is good. **Early Purple Head** is especially promising. When the heads are cooked the purple colour disappears.

CELERIAC

Celeriac is known as turnip-rooted celery, root celery, or knob celery. In celery, the stem forms a mere basis to the leaves, but in celeriac it is developed into a knob that measures 2 to 4 inches across.

Prague is the leading variety, though some prefer **Delicacy**. Other varieties are **Apple** and **Early Paris.**

CELERY

Celery is moisture-loving. The significance of an adequate moisture supply needs emphasis with respect to this crop. It requires a long

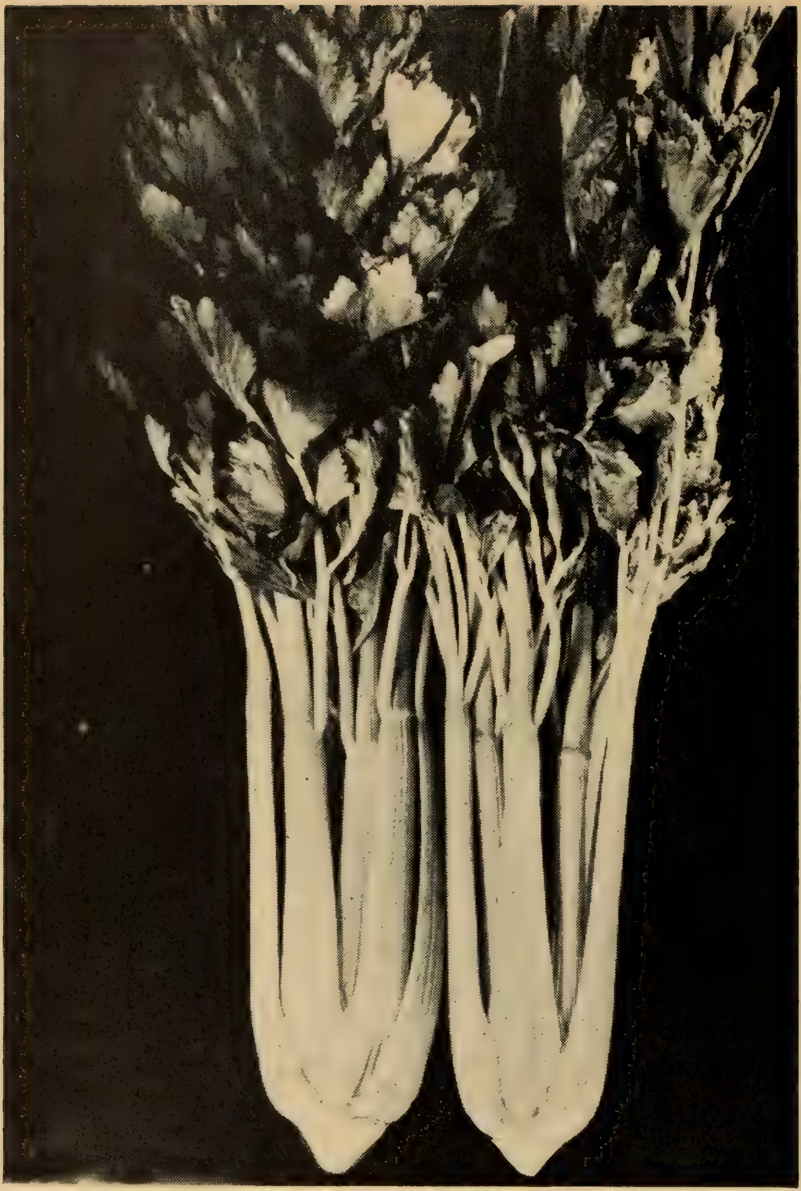

Fig. 14. Golden Plume celery.

growing season, and hence the seed must be started under glass. Celery shows a lack of tolerance of cool temperature in early stages which results in premature seedstalk development, though at other times it thrives best when the weather is relatively cool.

A.—Golden, Early, or Summer Celery. Characterized by its comparatively light-green or yellow-green colour, its ease of blanching, and its early maturity.

1. *Golden Self-Blanching type.* Plants with medium-sized hearts which grow up rapidly after blanching has started; total height commonly 1½ to 2 feet, and stalk length 8 to 11 inches to the first branches; leaves yellowish-green; stalks somewhat stringy, and if grown rapidly quick to wilt in marketing; readily blanched to a creamy-yellow colour; quality only fair, but has been popular because of the attractive appearance.

(a) Tall strains: Tall Golden Self-Blanching (Improved Old Golden, Tall Strain, Tall French, Vilmorin Improved), Florida Golden.

(b) Intermediate strains: Supreme Golden.

(c) Dwarf strains: Golden Detroit, Dwarf Golden Self-Blanching.

2. *Golden Plume type.* Usually more vigorous, somewhat more erect, and with a capacity to develop a heavier heart in a shorter length of time than strains of the Golden Self-Blanching type; strains not so tall as the taller strains of the preceding

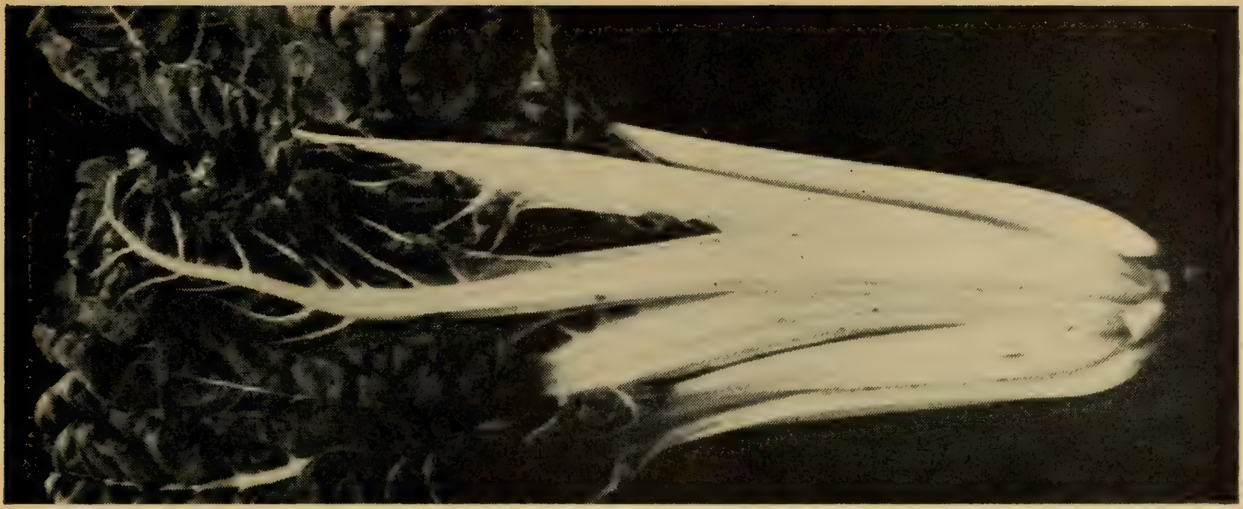

Fig. 15. Swiss chard.

type; blanched easily to a golden-yellow colour; quality only fair; somewhat resistant to blight; fairly difficult to keep in storage.

(a) Tall strains: Golden Phenomenal, Early Fortune, Hoover Special, Tall Golden Plume No. 4162, Resistant Golden Plume.

(b) Intermediate strains: Golden Prize, Golden Treasure.

(c) Dwarf strains: Wonderful, White Plume, Golden Plume, Nonbolting Golden Plume.

B.—Green, Late or Winter Celery. Mature later, heavier, and of better quality than the golden or summer type; can be stored longer than the self-blanching varieties.

1. *Easy Blanching type.* Plants somewhat shorter than Golden Self-Blanching, less erect, more vigorous, darker-leaved, slower to blanch, and easier to keep; leaves very green, glossy; stalks numerous, thick, rather brittle; intermediate between golden and dark-green celery in blanching characteristics; medium early, a little later than Golden Self-Blanching. This type can be classified as "green" celery with moderate blanching, yet with additional blanching it can be marketed in competition with the self-blanching and plume types.

Easy Blanching, Crispheart, Sweetheart, Pride of the Market, Newark Market, Fullheart.

2. *Dark Green type.* Late. Leaves rich dark green; usually not blanched when sold directly from the field. This type is now very popular with consumers; sometimes partially blanched in the field; if placed in storage or banked with soil in the field a certain amount of blanching occurs; usually about 16 to 20 inches tall, with stalks about 5 to 8 inches to the first branches; stalks large, round edged, thick, and almost free from ribbing; heart heavy.

Giant Pascal, Utah (Salt Lake), Utah 15, Utah 99, Emperor, Columbia, Fordhook, Winter King, Epicure, Summer Pascal, Paragon.

C.—Intermediate Class. Different from the others in combining the colour of the golden or summer type with the round stalks of the later type.

Golden Pascal, Masterpiece, Cornell 6, 9, and 19.

D.—Pink or Red Celery. Nut-like, quite distinctive, and pleasant flavour; the pink, red, or purplish colour distributed over the outer stalks, but mostly at the margins of the inner stalks which are otherwise white or cream in colour.

Superb Pink, Market Pink, Leicester Red, London Prize, Suttons A. 1.

Leading Celery Varieties

In early or yellow celery, the leading variety is **Golden Plume.** The most extensively grown late, winter, or green variety is **Utah.** Somewhat more refined strains are found in Utah 15 and Utah 55, which also are smoother ribbed and less stringy. **Newark Market** and **Fullheart** seem to be more popular in the Burlington district than in other districts.

Celery varieties that are resistant to fusarium yellows include **Florida Golden, Resistant Golden Plume,** and such semi-green or green sorts as **Cornell 6 and 19, Sweetheart, Paragon** and **Utah.**

CHARD

Chard, also known as Swiss Chard and Sea Kale Beet, is a foliage beet. The broad succulent leaves are prepared for the table like spinach, and the leafstalks and midribs are cooked and served much like asparagus. The flavour of the stems is quite delicate. The crop is useful from midsummer to fall. It withstands summer heat and long days better than most greens.

Lucullus is the most popular light-green or bright yellowish-green variety. The leafstalks are over an inch thick and bare for more than a foot of their 3-foot length. **Fordhook Giant** is larger, darker green, and with somewhat broader, more crinkled, or savoyed leaves and broader stalks.

Rainbow is said to be a cross of Improved Swiss Chard and beet; it has large crumpled and pitted leaves with stalks in white, pink, green, orange, and yellow.

Rhubarb Chard is red in colour, but is not so vigorous as Lucullus. It is really a Chilian or Brazilian beet.

Perpetual Beet and Spinach Beet are sometimes used as synonymous with chard, but in them it is the foliage only, not the midrib, which has been developed.

CHINESE CABBAGE*

Chinese cabbage when sown in the spring commonly fails to form desirable heads. This fact has led many persons to conclude that this vegetable cannot be grown successfully in their area. Seeding at the proper time in summer and selection of suitable varieties are essentials that must not be overlooked. Chinese cabbage is used fresh for salad or boiled as greens.

1. Leaves obovate; petioles short, broad, prominently winged, flattened or only slightly concave on adaxial surface.
    A. Plants forming true heads. Leaves setose.
        B. Heads long and narrow with leaf tips overlapping to form pointed apex; plants erect; leaves dark green, finely savoyed; secondary veins many, appearing parallel: Chihli.
        BB. Heads medium to long with leaves curling outward at tips; plants semi-erect; leaves intermediately green, coarsely but heavily savoyed; secondary veins medium in number, palmate: Pe-Tsai.
        BBB. Heads round or only slightly oblong with leaf tips overlapping; plants spreading; leaves intermediately green, moderately savoyed; secondary veins medium to few in number, palmate: Wong Bok.
    AA. Plants not forming true heads.
        B. Leaves setose; leaf margins incised, very wavy; leaves intermediately green, moderately savoyed: Hagaromo.
        BB. Leaves glabrous.
            C. Leaf margins incised, very wavy; leaves yellowish green, coarsely but lightly savoyed: Giant Shuntang.
            CC. Leaf margins entire to slightly undulate; leaves light yellowish green, surfaces generally smooth, but occasionally very slightly savoyed: Santo-Sai.

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* Largely adapted from U.S. Dept. of Agr. Cir. 571 by J. E. Kraus.

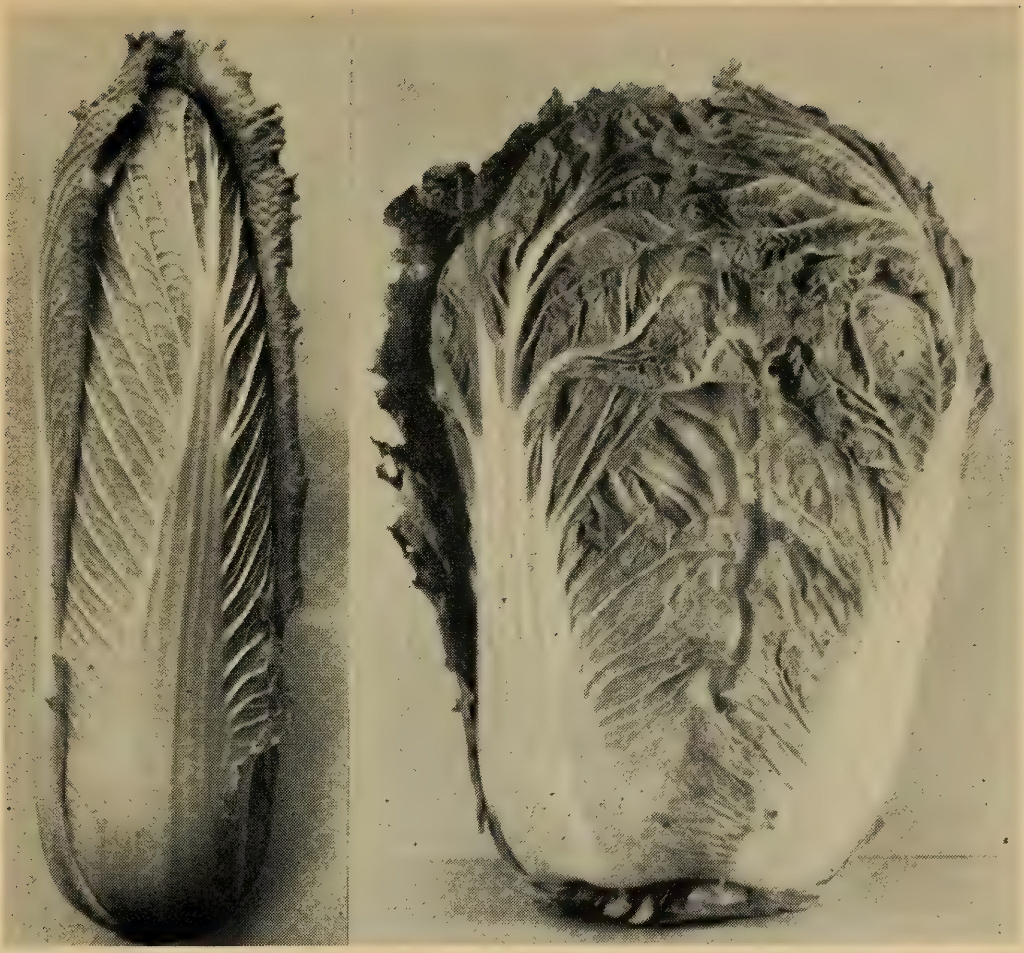


Fig. 16. Chinese cabbage. *Left:* Chihli. *Right:* Sakigake.

2. Leaves orbicular; petioles as long as leaf blade, not prominently winged, deeply and narrowly concave on adaxial surface; plants not forming true heads, erect; leaves not overlapping, dark green, glabrous, thickly covered with bloom, not savoyed; leaf margins entire, very slightly waxed: New Joy.

Chihli forms long, slender (15 to 18 x 4 to 6 inches) heads. It is one of the most reliable heading varieties and is about a week earlier than Pe-Tsai and Wong Bok. The true Pe-Tsai is distinct, but many seedsmen use this name interchangeably with other varieties. The head is medium to long (10 to 12 x 4 to 6 inches) and usually opens at the apex. **Seoul Market** is similar to Pe-Tsai but the head is slightly longer; **Sakigake** is earlier, and its heads are shorter. **Market Pride** also resembles Pe-Tsai, but the head is shorter and more compact. **Wong Bok** forms short, broad heads. It is quite likely to form seedstalks when the plants are comparatively small and is quite late. **Chinese White** refers to strains of Wong Bok in which the greenish cast of the leaf petioles is practically absent. **Cheefoo** resembles Wong Bok but is somewhat earlier, is slightly narrower, and does not form seedstalks so quickly.

Hagaromo does not form compact heads, is of the loose-leaf type; the inner leaves are yellowish white at maturity; it is semi-erect, 10 to 15 inches high, 2½ feet wide, and medium late to late. **Giant Shuntang** is also of the loose-leaf type, semi-erect, 12 to 15 inches high, 2½ feet wide; late. **Yellow Shuntang** is earlier and somewhat smaller, and the leaf margins are less wavy and less deeply incised. **Santo Sai**, sometimes called Chinese lettuce, is loose leafed, semi-erect to spreading, 10 to 12 inches high, 20 to 24 inches wide, and medium late to late.

New Joy is sometimes referred to as Chinese mustard. It is a non-heading type, erect but often weak growing, medium to small, 15 inches high, and 18 inches wide. The petioles, which are as long as the leaf blade, are the edible portions. Distinct from all others, it is of very little value and does not seem to possess any desirable characteristics that are not present in heading types. **Nagasaki** is medium to weak in growth, small, 10 inches high, 15 inches wide, semi-erect, and medium late to late. Japanese seedsmen claim that **Goldenheart** is a cross of Chinese cabbage and broad-leaved mustard; it is not promising.

CORN, SWEET

Because of cross-pollination, corn is maintained in an extremely heterzygous condition (except in inbreds as discussed later). Most corn varieties are so considerably mixed that they are changed readily by selection under a new environment, and there are innumerable strains within most important varieties. In fact, there may be greater differences among strains within a variety than among varieties of the same seasonal requirements. Thus, in choosing the strain of corn to plant, it is important to know that it has performed well in the given locality or under similar soil and seasonal conditions.

Open-Pollinated Sweet Corn Varieties

A.—Varieties with white kernels in the milk or boiling (roasting) stage.

1. Ears black at maturity; the kernels still white when in prime condition for consumption.
   - (a) Early: Pickaninny.
   - (b) Later: Black Mexican.
2. Ears white at maturity.
   - (a) Early: Midget, Early June, Early Surprise, Early Market.
   - (b) Later: Country Gentleman, Howling Mob, Stowell and Early Evergreen.

B.—Varieties with yellow kernels in the milk or boiling stage.

1. Ears small (4 to 5 inches long; 8-rowed); earliest group: Altagold, Banting, Golden Gem, Golden Midget.
2. Ears medium or intermediate size (5 to 6 inches long; 8-rowed): Goldban, Dorinny, Golden Bantam, Charlevoix.
3. Ears large (8 to 9 inches long; 10- to 16-rowed): Burbank Golden Bantam, Bantam Evergreen, Golden Early Market, Golden Early Sweet, Golden Wedding, Improved 10- to 14-Rowed Golden Bantam, Whipple's Early Yellow, Golden Giant.

Golden Bantam has long been considered the standard of excellence in open-pollinated yellow sweet corn. The true strain of Golden Bantam is 8-rowed. However, many strains are available, some of which are 10-, 12-, and even 14-rowed. In areas where Golden Bantam is somewhat too late, growers favour such early yellow varieties as **Banting, Golden Early Market,** and **Golden Early Sweet.** Widely grown late varieties are **Stowell Evergreen, Country Gentleman,** and **Howling Mob.** However, hybrids have assumed chief importance. (The seasons of maturity of various varieties and hybrids are compared later).

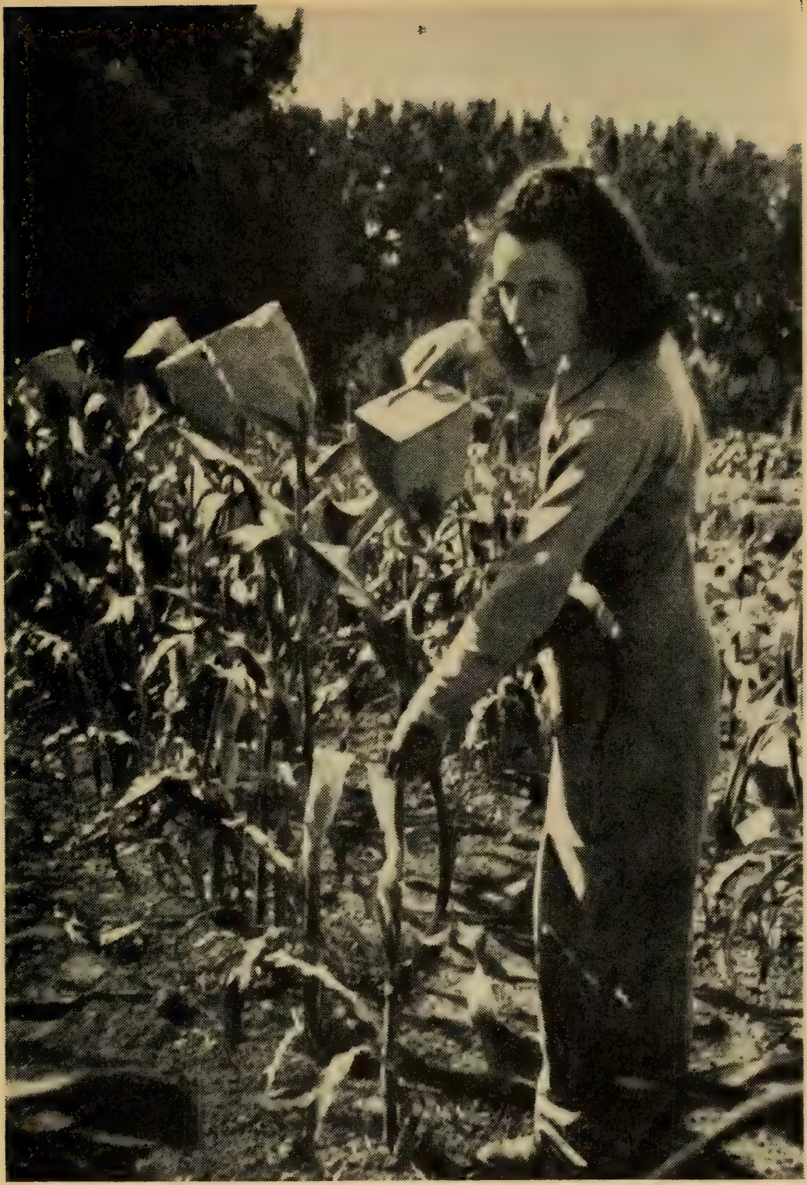


Fig. 17. Inbreeding sweet corn. Note the tassel bags (above) and silk bags (below).

Sweet Corn Hybrids

Hybrid seed is produced by specialists who maintain the inbreds. The commercial crop of seed is produced by growing rows of the two parents in an isolated field and detasseling the female or seed parent.

POLLINATION TECHNIQUE

For inbred lines an open-pollinated variety that has certain characteristics desired by the breeder is selected. Each plant within a given block of this open-pollinated variety should be self-pollinated. For this purpose, a transparent bag made of heavy Glassine material, 3½ x 7½ inches in size, is placed over the developing ear shoot before the silk shows. It is a good practice to cut off the tip of the shoot to encourage the growth of a straight-topped, brush-like silk. Such silks are easier to pollinate. In a day or so, when the silk begins to show in the transparent envelope, a wedge bag made of heavy kraft paper is placed over the tassel of the same plant. A day later, the tassel is cut off while still enclosed in the wedge bag. The Glassine bag is removed from the silk, and the loose pollen in the wedge bag is poured on the silk. The wedge bag, with the loose tassel still in it, is then slipped over the silk and tied securely. The seed of such a selfed plant is kept separate and planted in an individual row the next season. Frequently 30 to 100 inbred plants or inbred lines are begun in this way.

In the second year, each plant in all the 30 to 100 rows or inbred lines is self-pollinated again. However, in the fall only 1, 2, 3, or as many plants as appear desirable are selected out of each row and kept separate for seed for the next year. This selection work is based on the plant characteristics the corn breeder wants in his inbreds. The selfing and selection process continues for several years until the inbred lines are reasonably pure for the characteristics desired by the breeder.

Continuous inbreeding normally results in plants that lack vigor, are small, and frequently have difficulty in reproducing themselves. When two inbreds are crossed, the vigor of their progeny is greatly multiplied. A common effect in plants inbred for several generations is a lack of pollen, or the production of pollen which is so weak that it is incapable of fertilizing the ear. Through such causes valuable inbred lines may easily be lost. To save them the breeder sibcrosses the inbred as soon as he discovers it is about to die out because of faulty self-pollination, i.e., he uses pollen from a brother plant in the same inbred line. In this way the inbred line is maintained without losing its hereditary composition.

Once an inbred line has been obtained the next step is to determine its ability to combine with another inbred to produce a progeny hybrid corn which is superior to open-pollinated corn or other hybrids on the market. Quite often the combining ability of an inbred is so poor that its progeny is inferior even to an open-pollinated corn. Such an inbred is worthless and should be discarded. However, inbreds vary considerably in their combining ability and sometimes yield exceptionally fine hybrid progeny. Thus each inbred must be tested individually for its combining ability by being topcrossed with an open-pollinated variety such as Golden Bantam; pollen from this variety is transferred to the inbred, and the resulting progeny is compared with others, accurate data being taken on yield, ear size, and so forth. When two inbreds are found to possess a high combining ability they are crossed together to produce a new hybrid corn.

In recent years it has been found that the test for combining ability of an inbred can be made even before the inbred has been entirely purified for its desirable hereditary characteristics. Thus the test is now made after the inbred has been self-pollinated only 2-3 seasons in succession. Normally it takes from 5-7 seasons to purify an inbred.

Commercial Production of Hybrid Seed

The initial production of inbred corn lines is best done by the specialized corn breeder. Since, however, the plant breeder may have neither the time nor space to produce many acres of corn for seed, he often turns over his small quantities of inbreds to a reliable farmer, who, in turn, plants each in an isolated field for increase. An acre will produce 800 to 1,000 pounds of seed under normal conditions. Usually 1 row of the inbred to be used as the male parent is planted for every 4 rows of the inbred to be used as the female parent. This sequence is used as often as

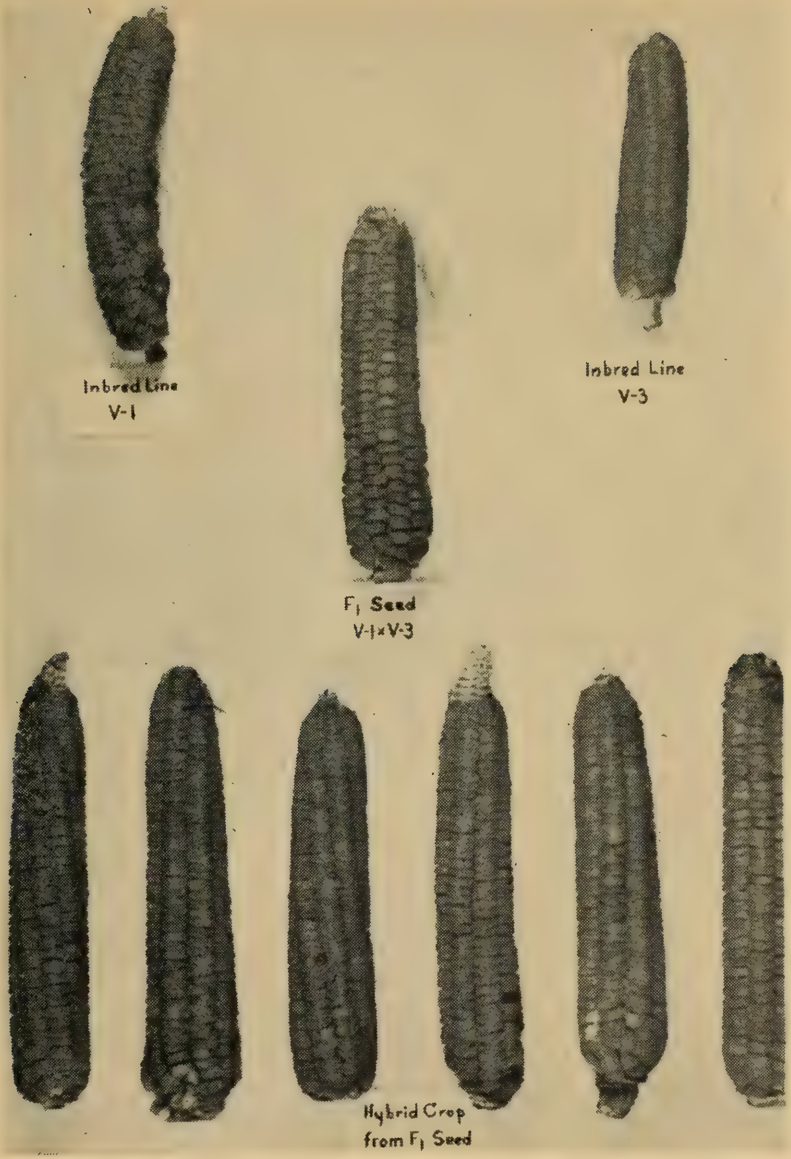


Fig. 18. Parentage of Vinecross B 5 hybrid sweet corn.

desired, or until the field is planted. As soon as the tassels on the female parent plants begin to show they are pulled out of the plant by hand. Detasseling must be done at least every second or third day to prevent the pollen of the female parent plants from ripening and fertilizing its own silks. The pollen from the male parent rows only must be permitted to ripen and pollinate the field.

DEFINITION

Hybrid is a word that is very loosely used by seedsmen and others. To avoid confusion, many corn breeders substitute "cross" for "hybrid", use a prefixed descriptive term such as single-cross, top-cross, double-cross, or three-way cross, and refer only to the offspring of the first generation after the cross.

Hybrid vigour is the stimulation which results from crossing two more-or-less unlike parents to produce hybrids. The increased vigour is commonly associated with increased yield and greater uniformity in the first generation after the cross. It cannot be fixed but rapidly disappears irrespective of further breeding.

Most sweet corn hybrids have originated since 1933, when Glen M. Smith, U.S.D.A., working at Purdue University, introduced Golden Cross Bantam. Private firms have also taken an active part in the production of sweet corn hybrids. As early as 1930, F. H. Woodruff & Sons commenced a breeding programme at Milford, Conn., and other firms have been encouraged by the outstanding inbreds developed by Dr. D. F. Jones and Dr. R. Singleton of the Agricultural Experiment Station, New Haven, Conn. The success with sweet corn has prompted breeders to do similar work with other vegetables.

Inbred. An inbred strain is one that is more or less uniform in gross characteristics produced by self—or sib-pollination (brother and sister) for several generations. Usually the inbred line is less vigorous than the original variety. Example: Purdue 39 or more simply P39 (Golden Bantam inbred).

Single-cross hybrid. The seed is produced by the transfer of pollen from one inbred to the silks of another inbred. The uniformity of plants, ears, and time of maturity are decided advantages for commercial canning. Examples: Golden Cross Bantam, Ioana, Purgold.

Double cross. A double cross is a hybrid of two single crosses that involves four different inbred strains. Here, both the male and female plants are vigorous hybrids. The seed quality and production are high, and there is every possible assurance of abundant pollen from the male parent, which is not true when this parent is of an inbred strain. Double cross hybrids form the basis of most field corn work as in this case yield is the factor most stressed, but with sweet corn the best hybrids at present are found in the single cross group.

Three-way cross. The seed is produced by transfer of pollen from an inbred to the silks of a single cross. It involves three inbred strains. It is slightly more uniform than the double cross, but is impractical unless an inbred line is available that is a good pollinizer. Example: Supergold Cross (P51 x P39) x P39.

Top cross. The seed is produced by the transfer of pollen from an inbred to the silk of an open-pollinated variety, or vice versa. A high percentage of the present sweet corn hybrids are top crosses, though they lack some of the uniformity of the single, double, or three-way crosses and some of their hybrid vigour. Examples: Honey Cross, Bancross.

Advantages. The first generation of hybrids from inbred lines, as compared with open-pollinated varieties, shows a marked increase in height of stalk, yield, uniformity of size, quality, uniformity of maturity, and resistance to disease. At least 75 percent of the sweet corn produced commercially today consists of hybrids.

Disadvantages. Hybrid corn is valuable chiefly in the first generation. Hybridization needs to be repeated each year by the breeder in order for him to have an available supply of hybrid seed. Seed produced from the hybrids yields less than the first generation and may be inferior to ordinary varieties. The uniformity in time of maturity in hybrids, though greatly advantageous to the canner, may not in certain kinds be so desirable as a longer period of harvest from the standpoint of the home or market gardener. There are inferior hybrids as well as good ones.

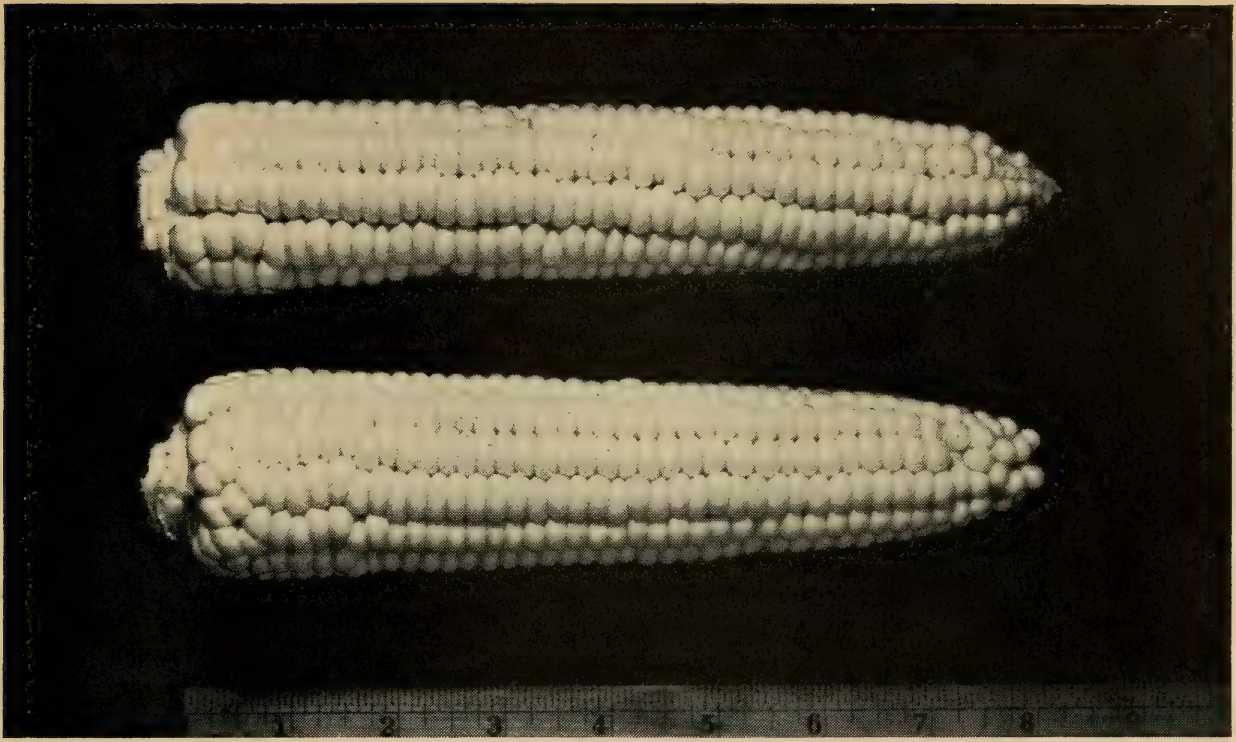


Fig. 19. Golden Rocket hybrid sweet corn.

Sweet Corn Maturity Seasons

In deciding on the best hybrid for any particular district one must first find a hybrid whose season is suitable. For this reason a list has been made of the different maturity seasons of the most widely used hybrids. On the same basis a comparison is made between hybrids and open pollinated varieties:

Season	*Hybrids*	*Varieties*
Extra Early	Seneca 60 Seneca 60.C13 Seneca Dawn Spancross 13.3 Midget Hybrid	Altagold Banting Pickaninny Golden Gem Golden Early Sweet Seven-Eights or Golden Midget
Early	North Star Golden Rocket Seneca Golden Sugar Prince Earligold Marcross C6.13 Northern Cross	Golden Early Market Dorinny Goldban Golden Sunshine
Early Midseason	Sunlite Minhybrid 202 Golden Succession Seneca Hybrid 92.28 Carmelcross Golden Glory Sencross Improved Sencross Seneca Chief Gold Rush Sachem Kennebec	

Season	*Hybrids*	*Varieties*
	Midgolden	Burbank Bantam
	Tendergold	
	Maine Bantam P39	
	Kingscrost Ear Pack Bantam B2	
	Kingscrost Improved B2	
	Kingscrost Ear Pack Bantam J9	
	Kingscrost Bantam E5	
Midseason	Vinecross B5	Golden Bantam
	Vinegold	Improved 10- to 14-Rowed Golden Bantam
	Mammoth Golden	Howling Mob
		Charlevoix
Late Midseason	Lee	
	Lincoln	
	Golden Cross Bantam	
	Improved Golden Cross Bantam	
	Purgold	
	Improved Purgold	
	Topflight	
	Kingscrost Hybrid #3316	
	Whipcross	
	Golden Hybrid #2439	Whipple's Early Yellow
	Ioana	
	Tendermost	
	OTA	
	Aristogold Bantam	
	Golden Security	
	Victory Golden	
Late	Illinois Golden #10	Black Mexican
	Erie	
	Tri-State	
	Cream-O-Gold	Golden Giant
	Kingscrost Golden Country Gentleman	Early Evergreen
Very Late	Wilson	Bantam Evergreen
	Goldenwood Improved	Country Gentleman
	Seneca Giant	Stowell's Evergreen
	Aristogold Bantam Evergreen	
	Bantam and Golden Evergreen Hybrids	

Evaluation of Sweet Corn Hybrids

The earliest sweet corn hybrid used in Ontario is **Seneca 60.** The ears are 6 inches long, slender, and 8- to 10-rowed. The quality and uniformity are only fair, but the yield is good considering its extreme earliness. **Seneca 60.C13** is similar except that it is a few days later, has larger ears, and is resistant to wilt.

Seneca Dawn is large eared and one of the best of the extra early hybrids. It is not adapted to mechanical picking. **Spancross C13.3** is another good extra early hybrid, with small ears, 10 to 12 rowed. It is a home garden type and is resistant to bacterial wilt.

Midget is a small, extra early, white-eared variety. It has been crossed with Golden Bantam. The hybrid was backcrossed on Midget and the yellow segregated back-crossed on Midget a second time. The next year the plants were selfed to obtain pure yellow types. These were selected for uniformity of growth habit and foliage color, and were then intercrossed. As a result **Seven-eights Midget** or **Golden Midget** was introduced. Seven-eights Midget is low in vigour but is high in quality. Yields

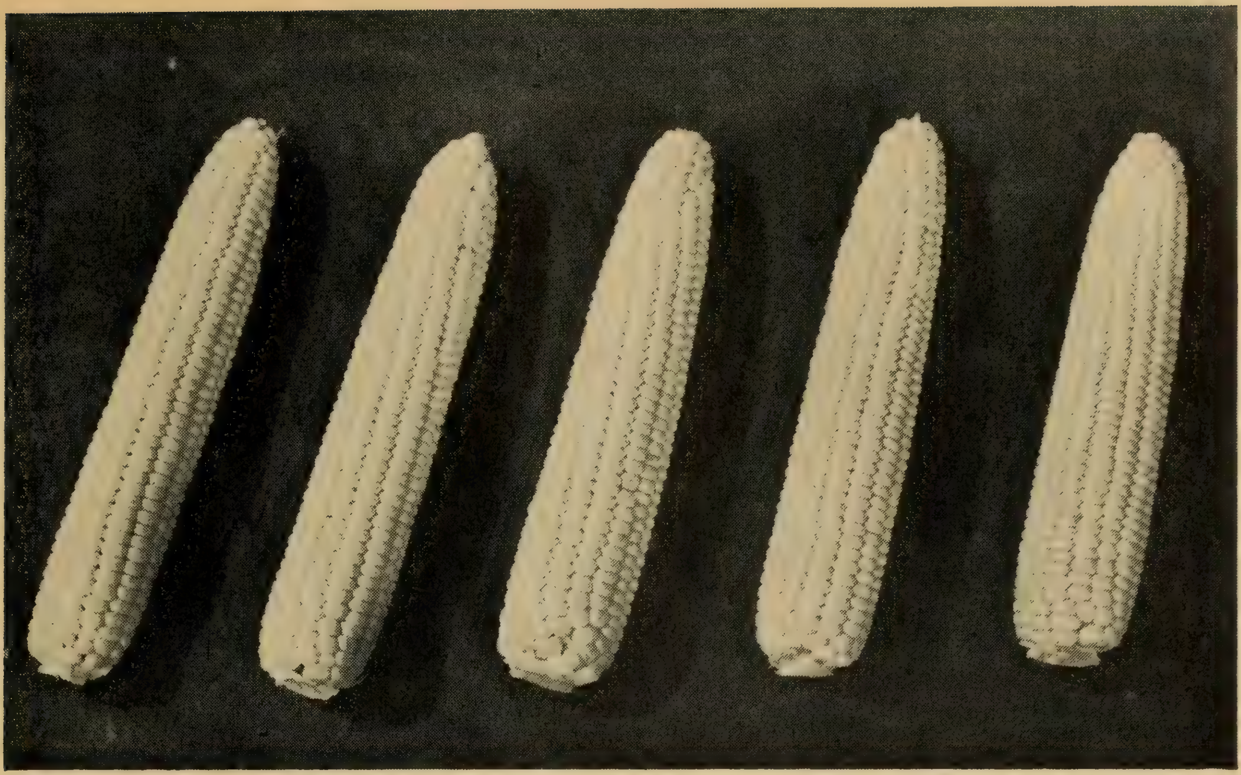


Fig. 20. Erie sweet corn hybrid.

have been increased by crossing Seven-eights Midget with an early dwarf strain of Golden Bantam. This hybrid possesses the sweet flavour which is lacking in many hybrid types.

Golden Rocket is an early 10- to 14-rowed, market garden type. It is superior in quality to its three early competitors, namely Spancross, Seneca 60, and Seneca Dawn. Along with **North Star** it is outstanding in central Ontario for market garden use. These two excel in the Niagara Peninsula and western Ontario for early sale from market gardeners. North Star is over a week earlier than open-pollinated Golden Bantam. It has large ears that are 7 inches long with 10 to 12 rows.

Seneca Golden is 12- to 14-rowed, with ears 7 inches long. It is valuable for second-early home and market garden use, as the quality is very good. The ears of **Sugar Prince** are an inch longer than those of Burbank Bantam and are 10 to 12 days earlier. It is 3 to 4 days earlier than **Marcross C13.6,** and superior to it in colour. The ears of Marcross are 7 to 7½ inches long, and 12- to 14-rowed. Although of only fair quality, it is the most widely used hybrid in Ontario from the home garden standpoint. It outyields most other early varieties. It is not adapted to mechanical picking.

One of the earliest of the large-eared hybrids and especially valuable to the market gardener is **Earligold.** Its ears are 6 to 6½ inches long and 12- to 16-rowed. **Northern Cross** exhibits marked hybrid vigour. It is a good type to sow as a companion crop with earlier sorts, and so insure a continuous supply of ears over a prolonged period. The ears are 7 inches long, 12- to 14-rowed, and for such size and vigour the crop becomes marketable earlier than expected.

In the early midseason group, **Sunlight** produces ears 7 to 7½ inches long, and is 10- to 12-rowed. The kernels are sweet, but the colour is pale. **Golden Succession** is a home garden kind. It does not show uniform maturity and the ears become ready for the table over a period of about two weeks, thus providing a continuous supply for home use. It is productive, with ears 8 inches long, and 12 rows of deep yellow kernels. The ears of **Seneca 92.28** are 10- to 12-rowed, 8½ inches long, slim, and with good quality. **Carmelcross** has been developed for market, canning, and home garden, and is a leader for canning in eastern Ontario and parts of central Ontario. It is a day or two later than Marcross, of larger size, better quality, and a heavier yielder.

In the early midseason group, **Golden Glory** is 12- to 14-rowed, with ears 7½ to 8 inches long. It is useful for canning cream style or whole kernel, and, as a companion crop along with Golden Cross Bantam, it extends the season of canning. **Sencross** is one of the few top crosses to survive the test of time. It is 12- to 16-rowed with ears 6 to 10 inches long. It is resistant to wilt, high yielding, with good kernel colour, and has found favour with both canners and market gardeners. **Improved Sencross** is 12-rowed and adapted to the market garden. **Seneca Chief** has ears 7 to 8 inches long, 12-rowed, with narrow deep kernels on a small cob. The table quality is very high as the ears are tender, sweet, and creamy. **Gold Rush** is an excellent home and market garden type. The ears are mostly 10-rowed and 6 inches long. The kernels are shallow, with good flavour. **Tendergold** is a day or two earlier than open-pollinated Golden Bantam, and is more productive. It is one of the best types for canning and freezing in central Ontario. The 12-rowed ears average about 7 inches long. It has good quality and is resistant to wilt.

For whole ear pack, **Kingscrost Ear Pack Bantam 8 Row B2** has been replaced by **Improved B2.** Its main competitor in Ontario is **Vinecross B5** which was developed at the Horticultural Experimental Station, Vineland, Ont. A slightly later hybrid for the whole ear pack is **Kingscrost Ear Pack Bantam 12 Row J9.** Its ears are 6½ to 7½ inches long. Still another very similar 8-rowed whole ear pack type is **Minhybrid 202.**

In the midseason group, **Mammoth Golden** is for market gardeners with a demand for a large eared type that is earlier than Golden Cross Bantam; ears 16- to 18-rowed.

In the late midseason group, **Lincoln** is vigorous and of good quality. Its ears are 7½ inches long and 12- to 16-rowed. **Lee** is higher in quality but lower yielding.

The most outstanding of all sweet corn hybrids is **Golden Cross Bantam.** This 10- to 14-rowed type was introduced by Purdue University in 1933. Since then it has been used extensively in western Ontario for commercial canning. In 1946, Purdue University replaced Golden Cross Bantam with **Improved Golden Cross Bantam.** This stock resembles the original, but the ears are borne slightly higher on the stalk, have a few more kernel rows, with higher yields, and fewer tillers. Purdue University has also introduced a drought resistant form in **Improved Purgold.**

Early types of **Improved Golden Cross Bantam** are especially valuable to canners and market gardeners in central Ontario. These are found in **Maine Bantam P39** (wilt resistant), **Midgolden, Kennebec,** and **Sachem.** The best of the early Improved Golden Cross Bantam types is possibly **Vinegold** as it is being maintained under Ontario conditions, having been introduced by the Horticultural Experimental Station, Vineland, Ontario.

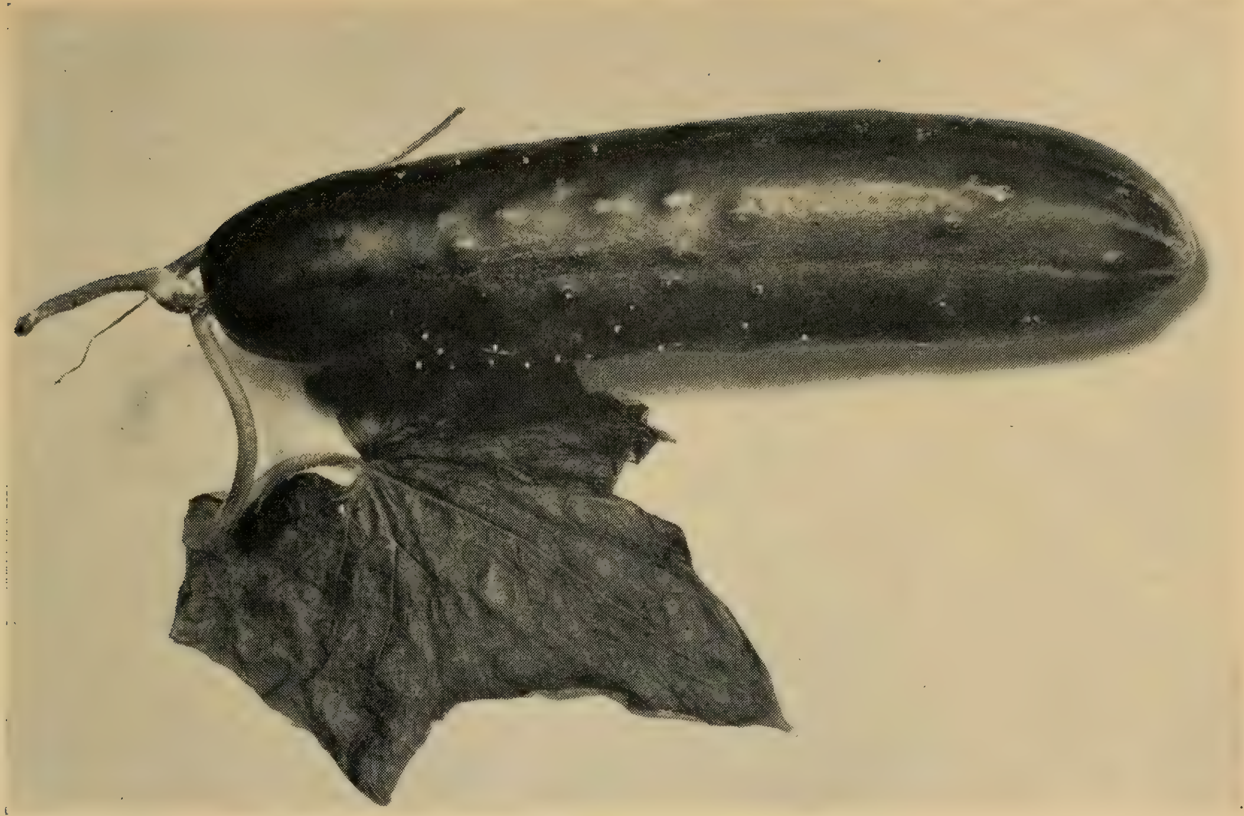


Fig. 21. Burpee Hybrid cucumber.

Kingscrost Hybrid #3316 and **Illinois #10** are late forms of Improved Golden Cross Bantam with little value in Ontario.

Topflight is a late midseason hybrid with rich coloured ears and deep kernels. It is popular for cream style pack. Ears 8 to 9 inches long, 14- to 16-rowed. **Whipcross** has been introduced to replace Whipple's Early Yellow. It is more vigorous than Whipple, the same in season, and is larger eared. A valuable type for truckers in Niagara Peninsula and warmer sections of Western Ontario is **Golden Hybrid #2439.** Its ears are 12- to 16-rowed, 8 inches long, these being covered by long husks that afford considerable resistance to ear worm. The plants are vigorous, uniform, with numerous dark green leaves, and is highly resistant to wilt. **Ioana** is a canning type, highly resistant to wilt, and fairly resistant to ear worm. Its ears are 7½ to 8 inches long and 12- to 14-rowed but it needs a very warm season.

One of the outstanding hybrids for freezing is **Tendermost.** It is a few days later than Improved Golden Cross Bantam. Ears 8 inches long, 14- to 16-rowed, and borne at an approximate height of 24 inches. The kernels are tender and sweet. **Ota** is a vigorous wilt-resistant stock with excellent husk coverage, and ears 8- to 12-rowed, 9 inches long.

Aristogold Bantam is a deep rooted, and drought-resistant type, with stalks 8 to 9 feet tall, and leaves and husks with a dark green healthy colour. Ears 12- to 14-rowed, rich yellow, with deep kernels, and good quality. Another drought-resistant variety is **Golden Security.** It has 14- to 16-rowed ears, 8 inches long, and is heavy yielding with excellent quality. Stalk height is about 12 inches greater than Golden Cross Bantam with higher ear placement on the stalk. **Victory Golden** is 12- to 16-

rowed, uniform, and of good colour and quality for canning. It is slow ripening and resistant to both smut and bacterial wilt.

The late varieties **Erie, Tri-State, Cream-O-Gold,** and various hybrid forms of Country Gentleman are only suitable in the warmest sections of Ontario. Erie has special value for canning as it is high yielding and wilt-resistant. Ears 9 inches long, cylindrical, slightly tapered, 12- to 14-rowed, 3 to 4 days later than Improved Golden Cross Bantam. Tri-State is of value for cream style pack, as the kernels are of good quality and exceptionally deep. Cream-O-Gold has 8- to 10-rowed ears, 7 to 8 inches long. Plants are uniform about 5½ feet high. Kernels are deep, on a very small cob. Quality is good. Many of the hybrid strains of Country Gentleman are white. One with yellow kernels, namely **Kingscrost Golden Country Gentleman,** has 8-inch ears which are straight, and with deep kernels of good quality. The plants are tall, with few suckers.

Only a few very late types will be mentioned. **Goldenwood Improved** is sturdy and drought resistant with 14- to 16-rowed ears. **Seneca Giant** is a market-garden type with ears that are 16-to 18-rowed, 12 to 14 inches in length, and of fair quality. The many **Evergreen Hybrids,** such as Bantam, Aristogold Bantam, and Golden, are sturdy and heavy yielding with large ears of excellent quality.

CORN, POP

Sweet corn is harvested at an immature (milk) stage for table use, but pop corn ears or kernels must ripen on the plant. This indicates, other things being equal, that pop corn needs a longer growing season than sweet corn. However, pop corn is sown safely somewhat earlier than sweet corn, perhaps a week earlier, as the hard, vitreous seed is not so easily damaged if the weather turns cold and wet.

As in sweet corn, the role of hybrids in pop corn is an important one, especially from the commercial standpoint. The procedure in producing hybrids is the same as outlined for sweet corn. In the case of pop corn, as was previously stated for sweet corn, it is not good practise to save seed from hybrid plants, as this seed is not pure.

The first hybrid pop corn variety was introduced by the University of Minnesota in 1935, as Minhybrid 250. It is not a commercial type as it was bred for a territory north of the corn belt. Two institutions in the heart of the corn belt, namely Kansas State College and Purdue University, have recently released 10 pop corn hybrids, three of which will be described later as Purdue 31, 32, and 38, as they are the leading commercial sorts at the present time.

Each of the three groups set forth contains many different coloured varieties, such as white, yellow, red, blue, and variegated. The attractive dark coloured varieties are for home use, but if one wishes to sell seed to the pop corn trade, it is necessary to grow a white, amber, or yellow variety, which has been long recognized as suitable. Colour has no influence on either yield or popping quality.

A.—Pearl group. Broad, rounded, smooth kernels, and heavy chaff (flower glumes) on the tips.

1. White ears or kernels: White Pearl, Spanish (Eight-Row).

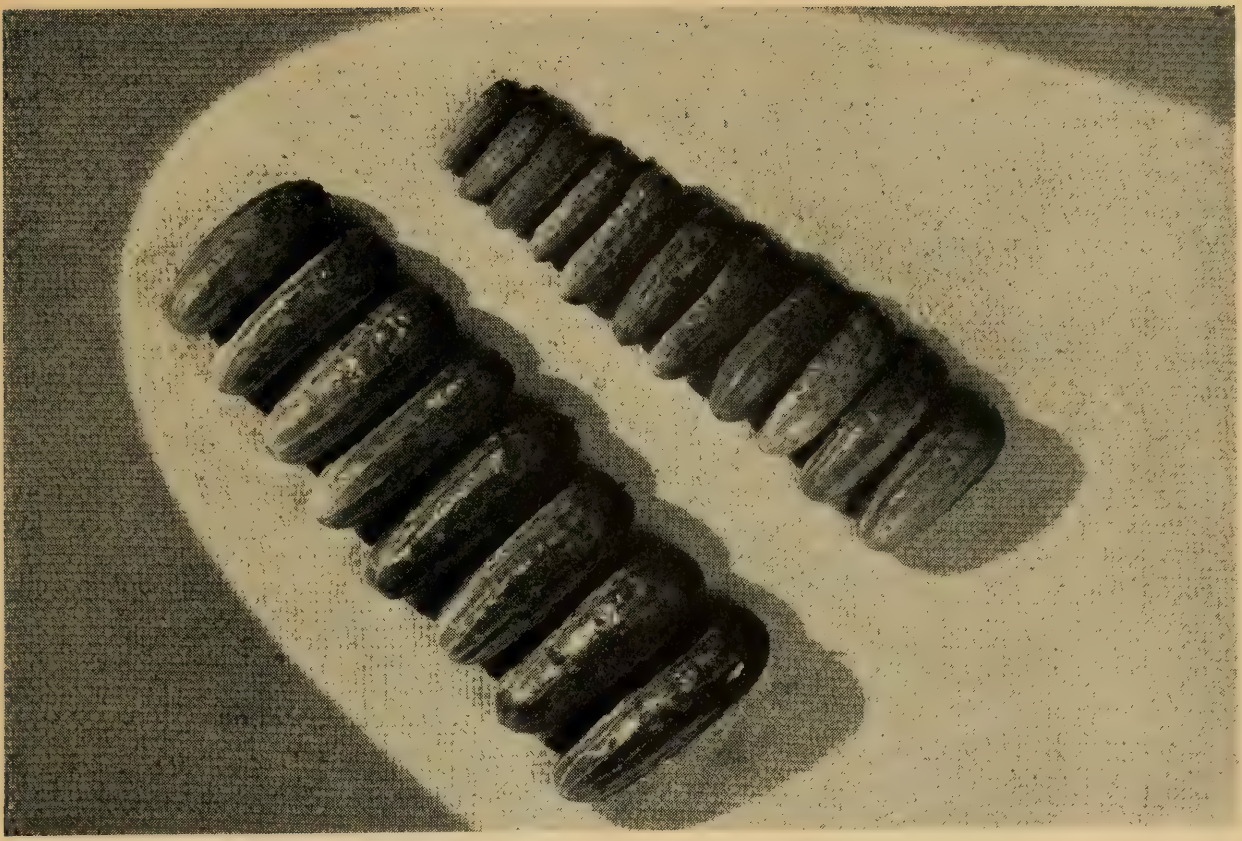


Fig. 22. Model pickling cucumber.

2. Yellow ears or kernels: Yellow Pearl (Golden Pearl), Supergold (Sunburst), Tom Thumb, Golden Queen (Queen's Golden), South American (Dynamite, Mushroom Giant, Giant Yellow, Giant Golden, T.N.T.), Superb, Purdue Hybrids 31, 32, and 38.
3. Blue-black ears or kernels: Black Beauty, Blue Snow.
4. Red to pinkish ears or kernels: Pinkie, Ornamental Strawberry.

B.—Hulless group. Shoepeg kernels (long and narrow, with either a pointed or a rounded crown), and very light chaff; ears short and thick; kernels not in distinct rows.

1. White kernels: Illinois Hybrid Hulless, Minhybrid 250, Japanese Hulless (Australian Hulless, Dwarf Rice, White Hulless).
2. Yellow kernels: Golden Hulless (Baby Rice).

C.—Rice group. Sharply pointed kernels, often ending in a hook or beak, and rather heavy chaff.

1. White ears or kernels: White Rice (Snowball).
2. Red ears or kernels: Red Rice.

Leading Pop Corn Varieties and Hybrids

The yellow Pearl group includes the varieties which are in heaviest commercial demand, e.g., **Golden Queen** and **South American.** Varieties of the Pearl group with white kernels are not popular, as they do not compare favourably with the yellow ones, either in yield or in eye appeal. Golden Queen has long, slim ears with 12 to 16 rows of smooth pearly kernels. It is late in season, and pops a creamy white. It resembles **White Pearl** except that the grain is golden cream in colour. South American is the pop corn which sells commercially on a large scale. It is a large eared, very late, heavy yielding type, which pops a rich creamy yellow colour. The kernels are big, and when popped are larger than any other variety, excepting Purdue Hybrids of South American type. The most widely used of these are **Purdue 31, 32, and 38.** They are extremely heavy yielding, and the kernels expand to an exceptionally large size. In the case of No. 31 and No. 32 the ears are long and slightly tapered, and with No. 38 the ears are large butted and ideal for mechanical picking.

An early form of South American is **Supergold.** Even though it matures a week earlier it is still too late for most of Ontario. **Yellow Pearl** is another heavy yielding very late type, with ears 7 to 8 inches in length, and attractive kernels which pop a true white.

Tom Thumb, Black Beauty, Blue Snow, and **Pinkie** are novelty types for home garden use, early enough to succeed even in the upper regions of central and eastern Ontario. The earliest of all pop corn varieties is Tom Thumb, and it is the best type for short season districts.

In the hulless group, **Japanese Hulless** has short, stubby ears about 3½ inches in length. It is a late midseason type, and is tender, sweet, and pure white when popped. **Golden Hulless** is the same as Japanese Hulless except that the kernels are a beautiful golden yellow colour instead of white. **Illinois Hulless** has hybrid vigor, which has resulted in increased yields and greater popping expansion. It is a late type. An earlier hybrid is found in the midseason **Minhybrid 250.** It surpasses Japanese Hulless in yield, earliness, and popping expansion, and should be suitable for central Ontario.

In the rice group, **White Rice** has long pointed grain, somewhat resembling rice from which it takes its name. It is late, heavy yielding, with ears 5 to 7 inches in length. **Red Rice** is an attractive home garden novelty too late for all but the warmest sections of Ontario.

CUCUMBER

Cucumber varieties are grouped in the discussion which follows into these groups: (a) Field-grown slicing; (b) pickling; (c) forcing or greenhouse; and, (d) novelty cucumbers and related types.

Field-Grown Slicing Cucumbers

The field-grown table varieties are characterized, with a few exceptions, by the presence of white spines; they grow to a fairly large size and retain their green colour for a comparatively long period of time. While the fruits are small they may be used for pickles, though the pickling type is usually grown for this purpose. When ready for market most of the white-spined sorts, under Ontario conditions, average about 8½ inches long. Probably the best of the shorter (about 7½ inches long), white-spined varieties is **Black Diamond** (Stays Green). Of those slightly longer and larger, the most extensively planted are **Straight 8, A & C** (Ace, Barteldes, Deltus, Colorado), **White Spine,** and **Clark Special.** These are the most popular with both the home and market gardener.

From this point a step is made to large-sized slicing types, the choicest being **President.** A popular variety, similar to President in length but more slender, is **Windermoor Wonder** (Vaughan), which at times is catalogued in Ontario as **Longfellow.**

Growers in Ontario have suffered serious losses in cool, moist seasons from cucumber scab *(Cladosporium cucumerinum).* **Highmoor** is almost

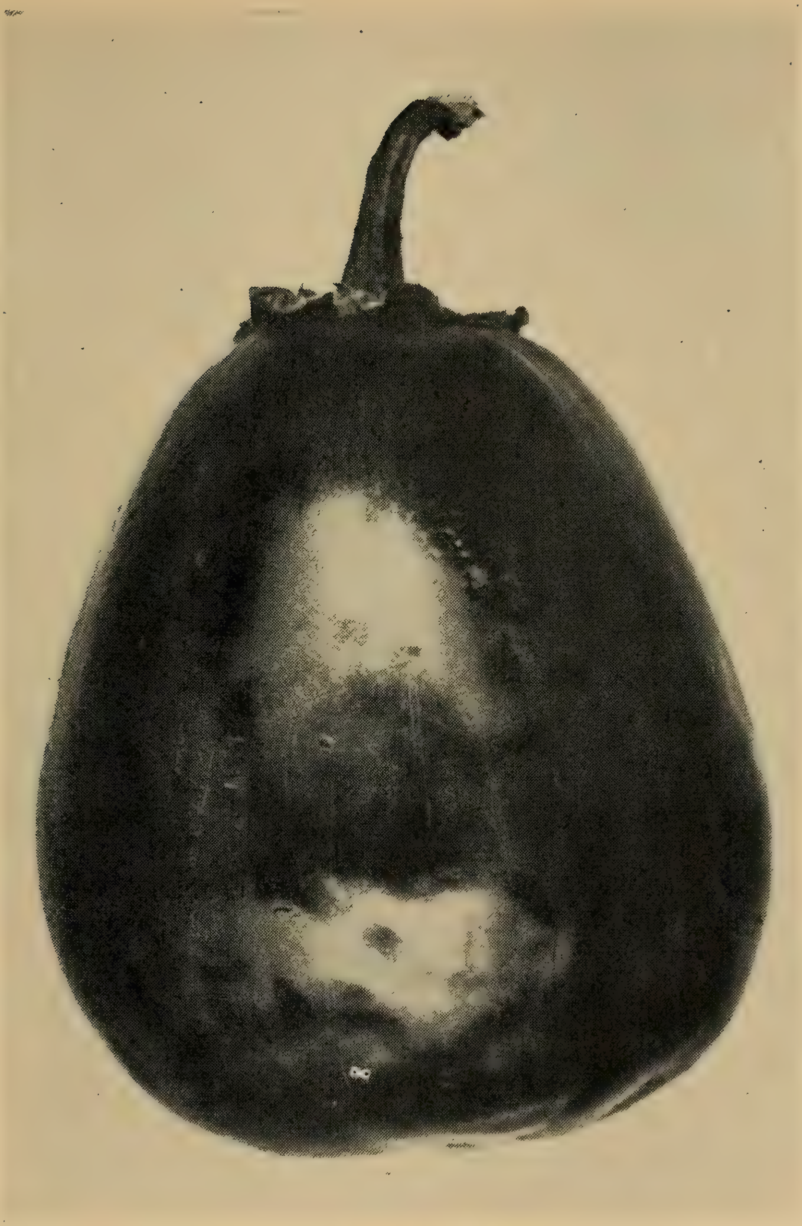


Fig. 23. Black Beauty eggplant.

immune to scab. It is a vigorous, slicing type, slightly later than Straight 8, with fruit that averages 8 to 9 inches long. It compares favourably with commercial varieties in quality and appearance and is of value to both the market and home gardener who is troubled with cucumber scab.

Improvement in the cucumber has been rapid within recent years. To a considerable extent this has been caused by crossing American with English types. In England an almost perfect type of cucumber has been developed from the greenhouse standpoint. The fruit is long and straight with few seeds, and a rich coloured smooth surface. In 1905 in the United States this English type was crossed with the American variety White Spine, and as a result **Davis Perfect** was introduced. Since 1905 the Davis Perfect type has been steadily improved, the first decided step in this direction being **Early Fortune,** followed by **A & C, Straight Eight, Marketer** (1941), and **Cubit** (1944).

A similar programme also was carried out in Canada resulting in the variety **Delcrow,** which was produced by crossing the English with the

American type. Although Delcrow lacks the attractive bright green colour of the most recent American varieties, it possesses a small seed space, very thick flesh, and under Ontario conditions is without equal where table quality is concerned. It is not a market garden or disease resistant type, but is liked by home gardeners who speciaize in only the choicest types. **Marketer** is an All-America bronze award winner, 8 inches long, dark green, with a small seed cavity.

Aside from the advance made in 1905 when the use of English types first seriously commenced in American plant breeding programmes a new and decided step forward culminated in 1945 with the introduction of **Burpee Hybrid.** This was the first cucumber hybrid to be distributed through commercial channels. The seed is produced by the combining each year of two inbred parents. In the case of Burpee Hybrid this has resulted in increasing the yielding ability of the stock. The hybrid is wilt-resistant, heavy yielding, vigorous, and with attractive 8-inch fruits. Judging from the first commercialized example of hybridity in cucumbers, a most promising method of evolving new, disease-resistant, vigorous types is now at hand.

Pickling Cucumbers

Pickling cucumbers are mostly black spined, smaller than the slicing varieties, less tapered at the tip in immature stages, more productive of small fruits, and somewhat less retentive of their green colour; they shrivel comparatively little or not at all during the pickling process. When the fruits become larger than pickle sizes they may be used for slicing, but other varieties are superior for this purpose.

In **Boston Pickling** the fruit is comparatively dark green and slender. **Chicago Pickling** has light-green fruits with a rounded base or shoulder, is somewhat too slender in the small sizes, but is especially good for dills. It is one of the most drought resistant varieties. The fruits of **Snow Pickling** are a little shorter than those of Chicago Pickling and lack the heavy shoulder at the stem end; it is popular for small pickles, but rather too short and chubby for dills. **National Pickle** resembles Snow Pickling in shape, although the fruits of the latter are somewhat more tapered at the tip. The small pickles are rather short and thick, and the larger sizes are smooth and cylindrical with well-rounded ends. The entire flesh of the fruit is uniformly thick so that splitting in the center and hollow sides is infrequent. **Model** and **Packer** resemble National Pickle in appearance and size but the colour is more intense, and in the case of Model the spines are white.

Danish Pickle is a large, thick-set, white-spined sort which has found some favour for chunk pickles. **Early Russian** and the still earlier **Early Siberian** are of little use for pickles except under conditions too adverse for better varieties. **Mincu** is of the Early Russian shape, but greener; it is somewhat lacking in desirable pickling qualities for large dills. It is white-spined and is, in fact, the earliest of all white-spined varieties and the best for home gardens in the colder sections of eastern and central Ontario. It is especially heavy yielding and sometimes sets four good sized fruits on a cluster. **Producer** is a similar type. **Earliest Yellow** and **Earliest Green** have some value in certain sections of northern Ontario because of their extreme earliness, but true stocks are difficult to obtain.

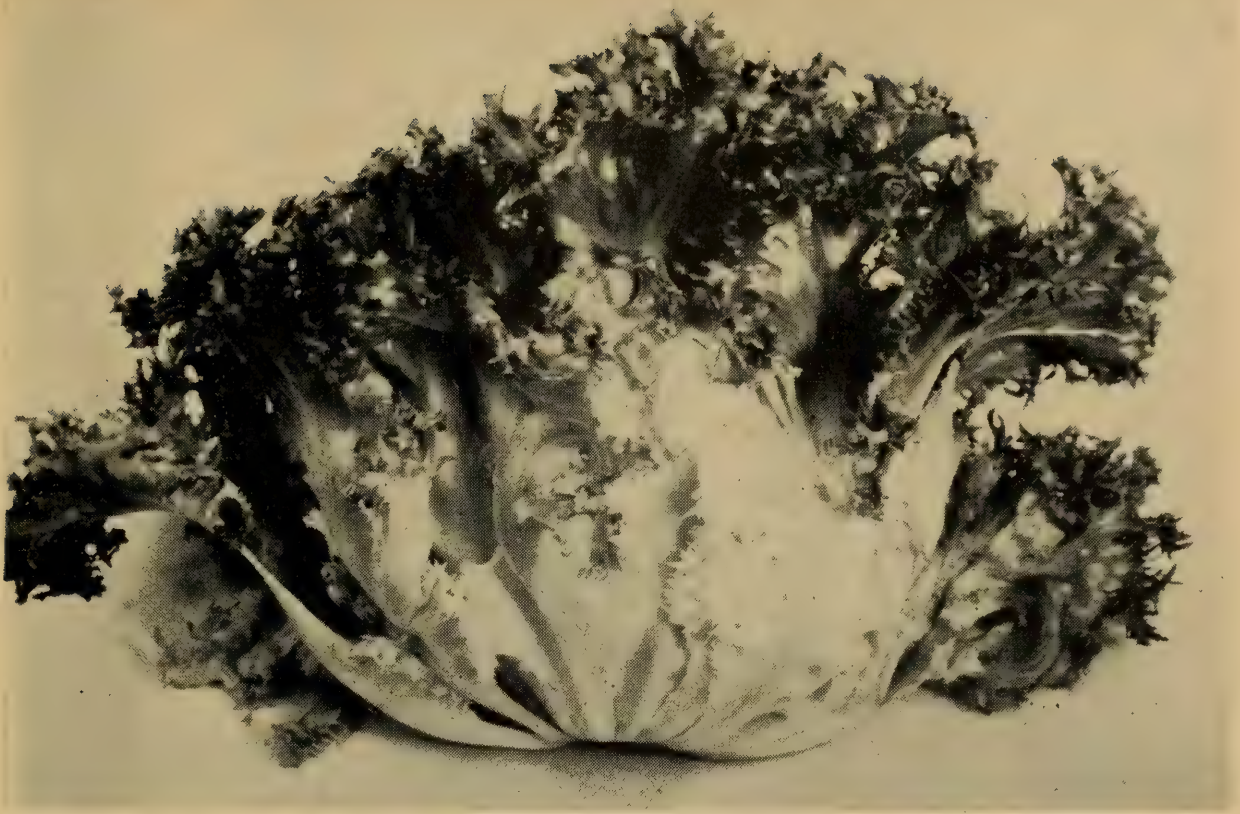


Fig. 24. Deep Heart Fringed endive.

Forcing or Greenhouse Cucumbers

The greenhouse group includes the long English sorts and certain others which are adapted to, and used primarily for, forcing purposes in greenhouses. The chief variety of the English type is **Telegraph.** The fruit matures without any pollination and seed formation, which is a condition described by the term natural parthenocarpy. The chief of the so-called American varieties are **Rawson Hothouse, Perry Special,** and **Irondequoit.** Pollination is done by bees, seeds are produced, and the mature fruit is formed.

Hescrow from the Horticultural Experiment Station, Vineland, and **Delcrow** from the Central Experimental Farm, Ottawa, are medium sized, smooth types that set and develop cucumbers without pollination.

Novelty Cucumbers and Related Types

In one ornamental curiosity that is not a true cucumber the fruit is 2 to 3 feet long, is strangely coiled and twisted like a snake, and never grows straight unless suspended. It is called **Snake.** Both **China Long** and **Chinese Three Feet** differ noticeably in both fruit and foliage from the true cucumber; the fruits are long. In **Japanese White,** the runners keep their tips raised from the ground like squash vines. The vines are vigorous and develop strong grasping tendrils, which enable them to climb wire netting or other support. Other whitish varieties are **Lemon, Crystal Apple,** and **White Wonder.** The White Wonder small white pickles are attractive when packed in glass containers.

For the backyard gardener with little space bush or dwarf cucumbers have been introduced. The most common form is **Midget.** It possesses some merit for pickling or small slicing.

West India Gherkin is not a true cucumber and has little commercial value. The term "gherkin" is commonly used for small fruits of the usual pickling cucumbers. **African Horn** has no particular value, other than as an interesting novelty.

EGGPLANT

The eggplant, or Guinea Squash, is greatly esteemed by some, disliked by others, and unknown to many. The varieties grown in Ontario bear large, purple fruits.

Blackie is the earliest and smallest variety. **Black Beauty** is the best in shiny black colour and general appearance where the season is long enough. **New Hampshire Hybrid** (Early Dwarf Purple x Black Beauty) and **Badger State** are earlier, and somewhat smaller. **Long Purple** is a midseason variety. The high-bush type, e.g., **Florida High Bush** and **Fort Myers Market** is too late for Ontario.

ENDIVE

Endive, or "winter lettuce", closely resembles lettuce in its cultural requirements although blanching is practised. It is more strongly flavoured than lettuce, and most persons do not like it as well.

There are two types of endive: (a) finely curled or fringe leaved, e.g., **Pancalier, Green Curled** (pink ribs), **White Curled,** and **Deep Heart Fringed:** (b) broad leaved, e.g., **Batavian** (Full Heart Batavian, Florida Deep Heart). The latter type, shipped in a green or partly blanched condition, is called "escarole". The so-called "French endive" is Witloof chicory. The curled varieties look the nicest on the table and are the best for salads. They have a nutty flavour. The broad-leaved type is better for stews.

GARLIC

There are two distinct types or varieties: (a) **Creole** (Early, Louisiana, White Mexican), and (b) **Italian** (Late or Pink). Creole is earlier than Italian, and is characterized by a flatter, broader leaf, a greener top, a shorter stem, fewer wrapper leaves, and larger cloves, and is a heavier yielder, but the keeping quality is somewhat inferior.

HORSERADISH

There is little choice of variety. Care should be taken, however, to obtain good, healthy planting stock of a strain that is giving good results in the region where it is to be grown. In 1899, the United States Department of Agriculture imported, from Bohemia, a variety known as **Mariner Kren** and, from Austria, the **Bayersdorf.** These importations may account for the name "Bohemian horseradish" used by growers to describe the smooth-leaved type from southern Europe.

KALE

Kale is a member of the cabbage family. It produces very large leaves which are used for greens and for soups.

The simplest kale is one known from ancient times and called in France the Cavalier kale. It may grow 5 to 6 feet high, and bears large flat leaves. Allied to it is the Thousand-Headed Kale, with simple leaves and a shorter stem from which spring many shoots. Other kinds

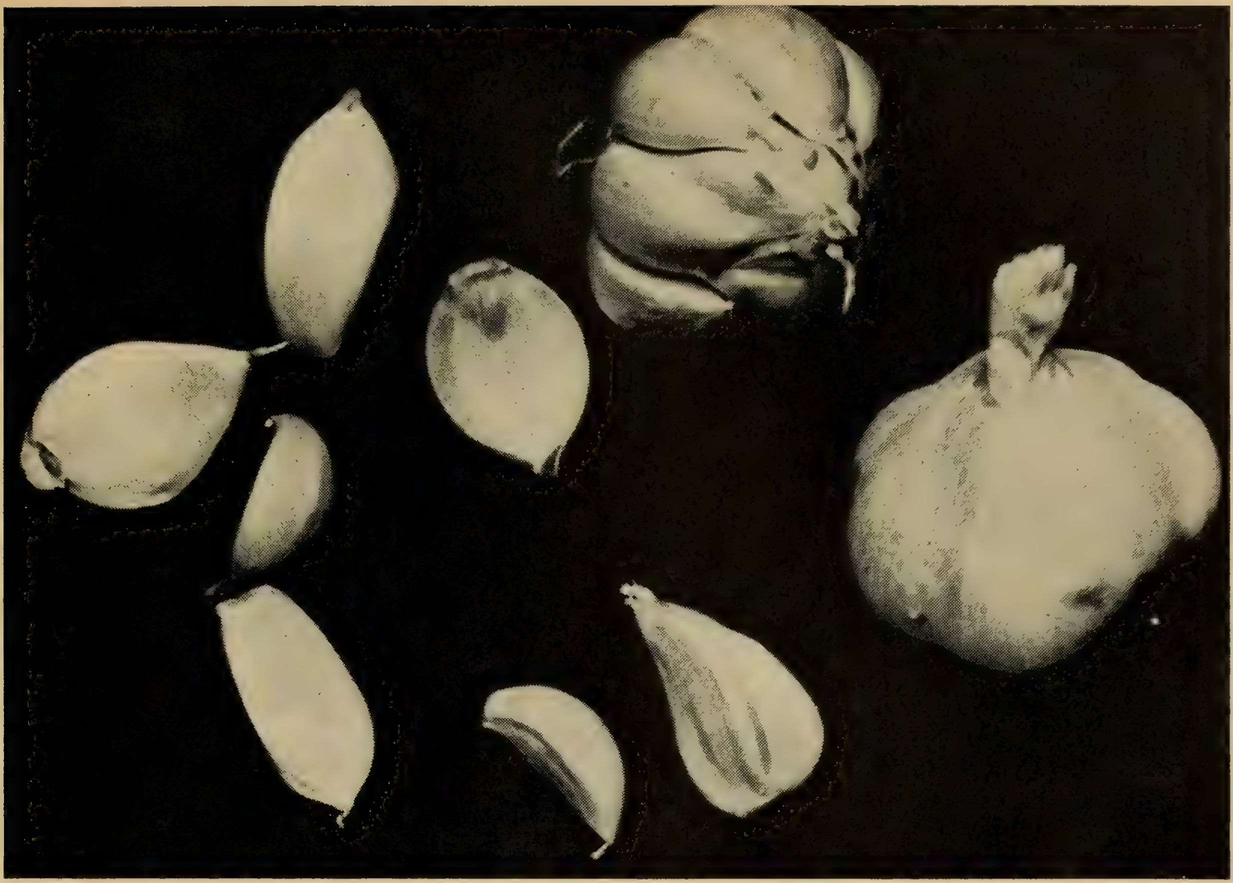


Fig. 25. Garlic cloves and bulbs at planting time.

show various degrees of division and curling of the leaves, which, in certain forms, are tinged with purple. The Scotch kales or borecoles are the best-known kales. Collard, which is grown in the South for greens, is a kale.

Some examples of dwarf kale (12 to 24 inches high) are **Dwarf Blue Scotch** (Dwarf Blue Cured), **Dwarf Green Scotch** (Dwarf Green Curled), and **Dwarf Siberian.** The leading tall kale (2½ feet or more) is **Scotch Curled. Jersey** (Thousand-Headed), sometimes called Bow Cabbage, is a tall sort used for chicken and stock feed. The **Hearting** types form a loose cabbage-like head of large curly leaves, e.g., **Drumhead Kale.** The **Asparagus** type approaches sprouting broccoli in appearance as it produces numerous edible branches.

KOHLRABI

Kohlrabi, resembles an aboveground turnip, the fleshy edible portion being an enlargement of the stem.

White Vienna (Earliest White), the most popular variety, is an early, dwarf sort, excellent for home and market garden and used also for forcing. The "bulbs" are globular and very light green; the flesh is clear white, tender, and crisp. **Purple Vienna** matures about a week later; the swollen stem and leaves are purplish, and the flesh is greenish white. **Green Kohlrabi** is seldom grown in Ontario.

LEEK

The garden leek forms a thick, fleshy structure like a large green onion plant without a bulb and is attractive in appearance with its silvery

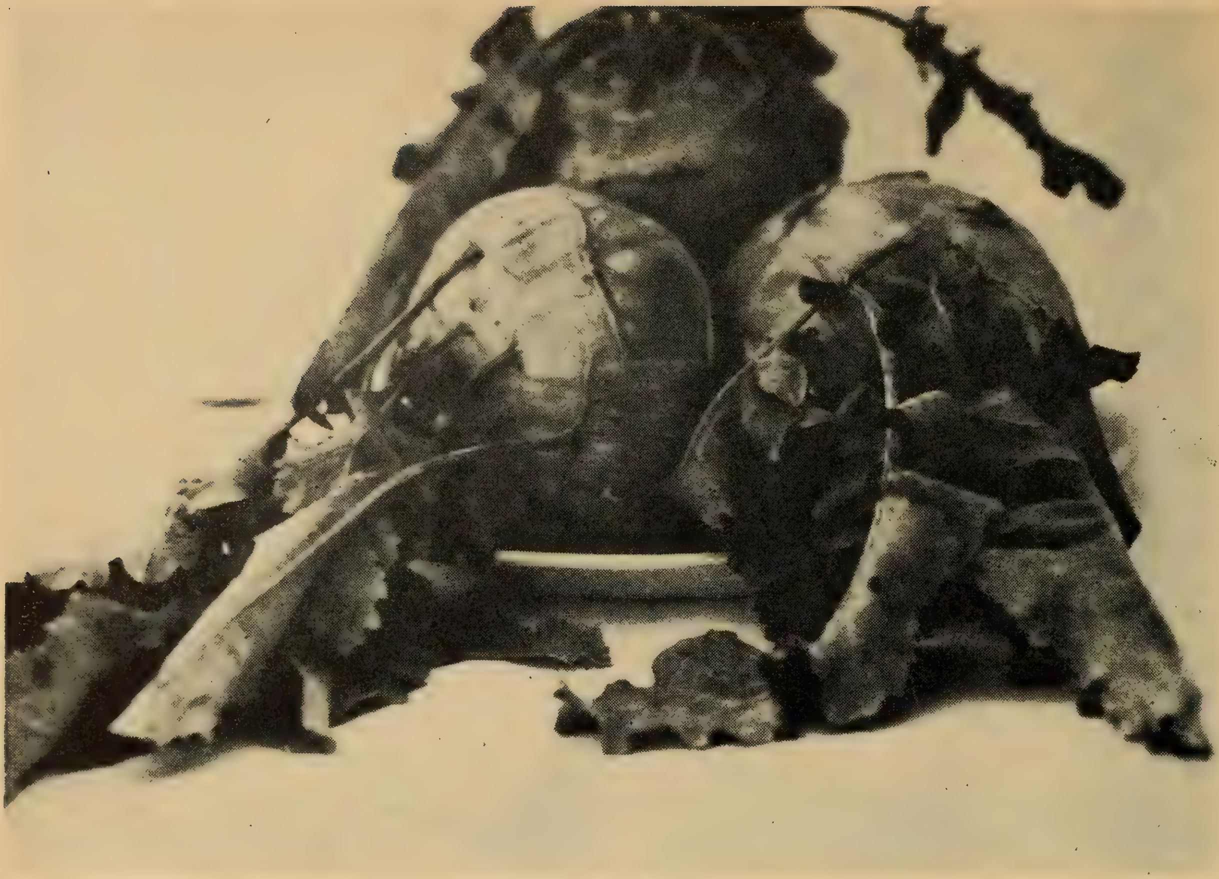


Fig. 26. Kohlrabi.

base and green top. The leaves are flat, in contrast to the round ones of the onion.

Carentan is probably as good as any. The leaves are thicker and darker green than those of **London Flag** (Large American Flag). **Musselburg** (Scotch Leek) forms a longer, thicker stem than London Flag (from which it is a selection), with large but somewhat narrower leaves. Ontario does not have a climate that is conducive to the growth of large attractive leek plants, and the differences between varieties may not be well defined.

LETTUCE

Lettuce, "the king of the salad plants," is probably the most popular and widely grown leafy vegetable.

A.—Head lettuce.

1. *Cabbage type.* Broad leaves; round or flattened heads.
   - (a) *Crisphead varieties.* Firm heads of crisp texture.
     - (i) Plants wholly green: New York, strains of New York (e.g., New York 12, Imperial 44, Imperial 456, Imperial 487, Imperial 515, Great Lakes), Hanson, Malta, Denver Market, Cosberg, Cosbia.
     - (ii) Plants tinged brownish, large part greenish: Iceberg.
     - (iii) Plants brownish, only small part greenish: Mignonette, Sugar Loaf.
   - (b) *Butterhead varieties.* Soft, fairly solid heads; inner leaves oily, soft buttery, or greasy in texture; heart moderately tightly folded, blanching to a light golden or buttery yellow; plants even less resistant to heat than the crisphead varieties; maturing in a little less time than the crisphead types.

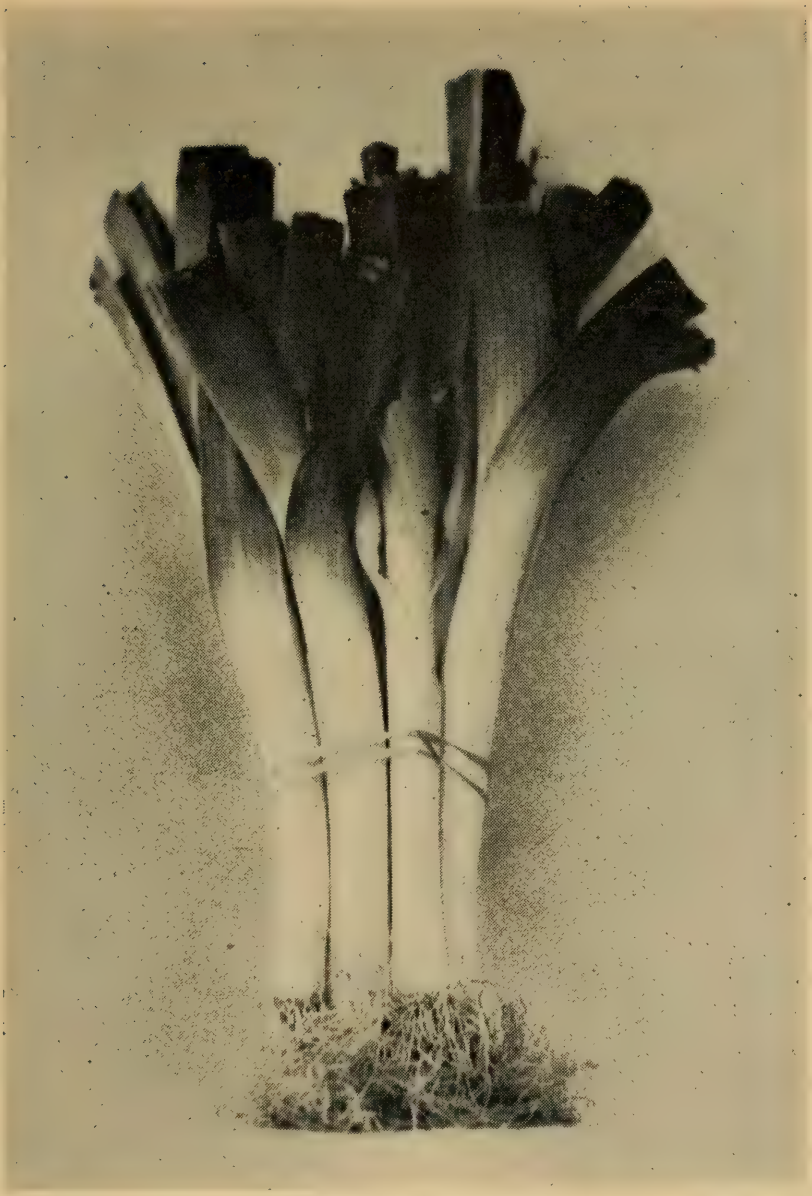


Fig. 27. Garden leek.

- (i) Plant wholly green.
  - a. Large heads: Deacon, White Boston, Salamander, All the Year Round, Wayahead.
  - b. Very small or miniature heads: Commodore Nutt, Tom Thumb.
- (ii) Plants tinged brownish, large part green: Big Boston, May King, Belmay, California Cream Butter, White-Seeded Tennis Ball.
- (iii) Plants brownish, only small part greenish: Brown Head, Continuity, Eureka, Brown Dutch.

(c) *Bunching varieties.* Semi-loose heads: Oak Leaf, Bronze Beauty.

2. *Cos or Romaine type.* Long, narrow (spatulate) leaves; elongated, upright heads.
   - (a) Large heads: Paris White, Dark Green.
   - (b) Small heads: Little Gem.

B.—Leaf lettuce. Loose, non-head-forming leaves.

1. Plants wholly green: Simpson's Curled, Early Curled Simpson, Black-Seeded Simpson, Grand Rapids, Boston Curled, Slobolt.
2. Plants brownish, only small part greenish: Prize Head.

C.—Stem type. No head; not edible except for the large, fleshy stem (peeled and eaten raw or cooked): Celtuce.

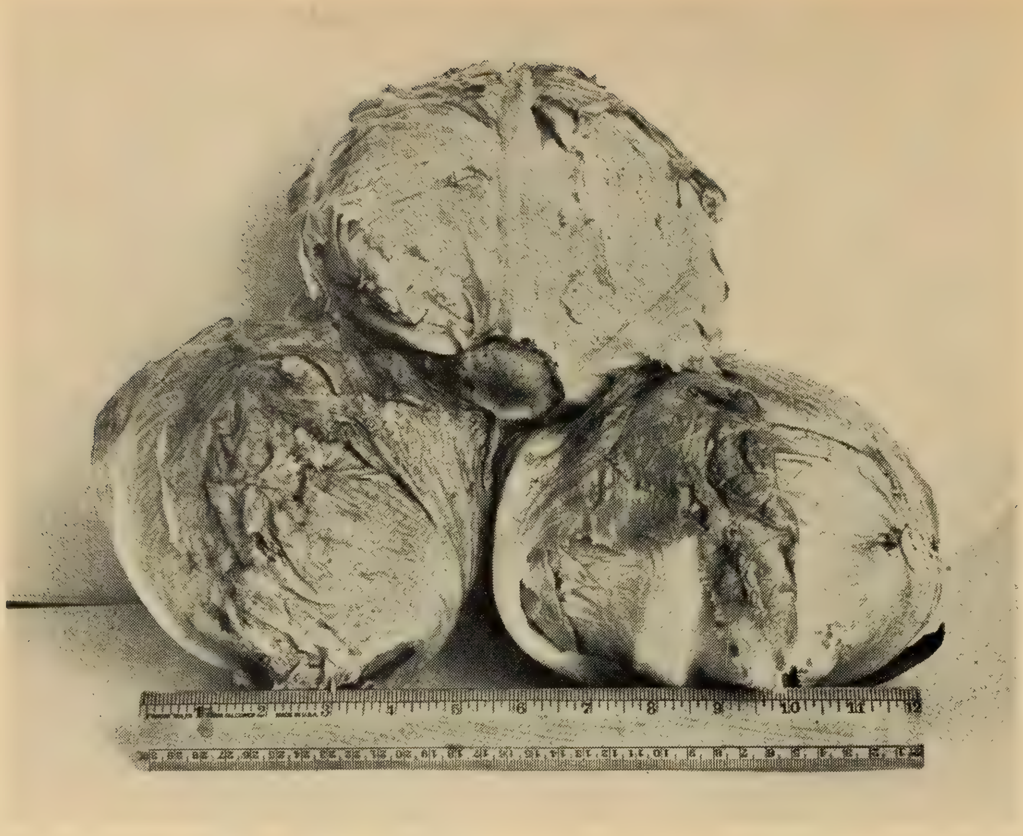


Fig. 28. New York 12 head lettuce. Long the leader, it is giving way to improved strains more resistant to tipburn and other troubles.

Most commercial field lettuce is of the crisphead, green, cabbage type. **New York No. 12** was the leader for some years, and is still grown extensively on upland soils. Though not so subject to tipburn as some varieties, it rots readily in hot weather. New strains have been introduced to help avoid this problem and **Imperial 456** has come to the fore in this connection, now being the leader for the summer crop on the large marsh land plantings. **Imperial 44** and **Great Lakes,** the latter a large, "ribby", dark-green type, are among the best for spring and fall plantings. **Imperial 515** does not head well on marsh land.

In the trade, the New York strains shipped from the Pacific Coast are known as "Western Iceberg" or "Iceberg." However, there is a distinct **Iceberg** variety.

Butterhead varieties, e.g., **White Boston, Big Boston, May King,** and **Salamander,** have largely been supplanted for market purposes on this continent by crisphead varieties. The flavour of the butterhead varieties is probably superior to that of the crisphead.

Bronze Beauty won an All America award as an Oak Leaf type that does not become bitter in hot weather. It is a vigorous home-garden variety with a brown tinge.

The cos type, which is popular in the British Isles, is somewhat more tipburn resistant than other heading types, but it quickly goes to seed in dry periods. It is less suited to shipping than either the crisphead or the butterhead types; hence it is more difficult to deliver to the consumer in good condition. **Paris White** is a leading cos variety.

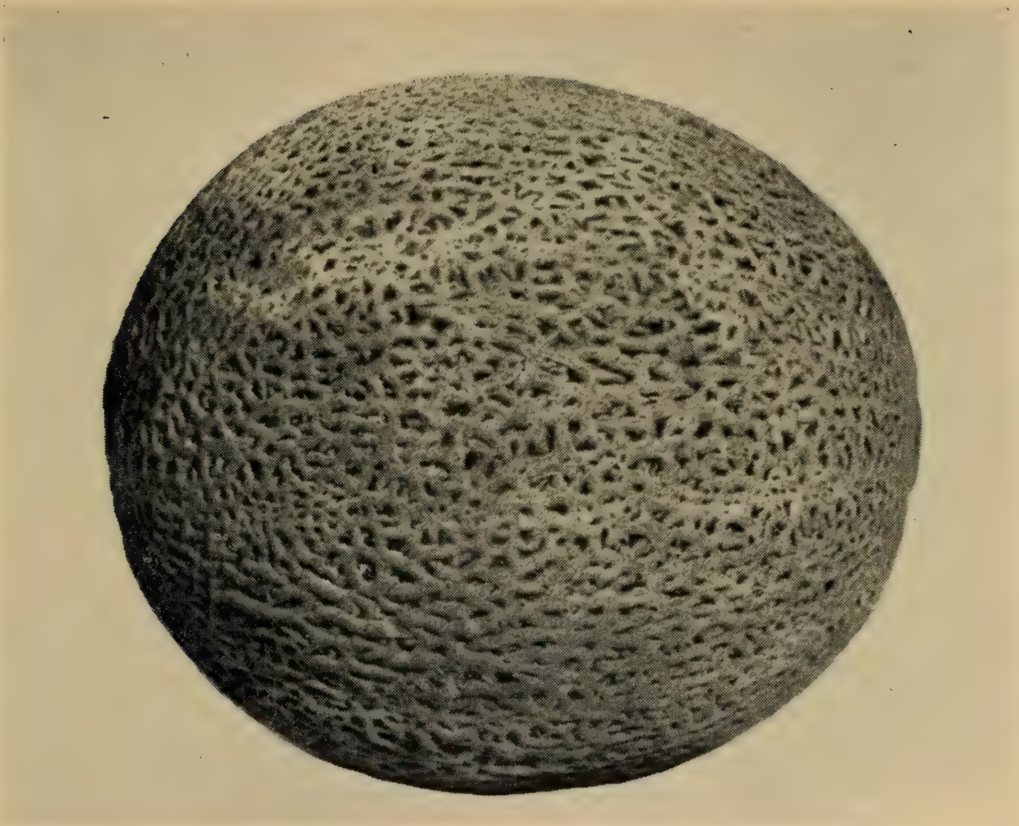


Fig. 29. Hale's Best cantaloupe or muskmelon.

Grand Rapids is probably the chief leaf lettuce for both outdoor and commercial greenhouse use. **Black Seeded Simpson** is preferred by some for outdoor culture because it is not excessively curled and is less often bitter. There are a number of strains of Grand Rapids, e.g., (a) *Ohio strain;* (b) *Tipburn strain,* which is said to be resistant to this disease when grown commercially under glass, the leaves are not so frilled but more savoyed than the regular strain, and which tends to form heads when grown outdoors; (c) *U. S. No. 1 strain,* which is said to be resistant to mildew; and (d) *Slobolt strain,* which was developed for its tendency to remain in condition for a longer period.

MUSKMELON

The use of the word "cantaloupe" on this continent is largely accounted for because commercial western growers considered it to be a more attractive or appealing name than muskmelon and so adopted it. As the type of muskmelon grown in the shipping areas of the west is mostly with a netted surface and shallow sutures the name cantaloupe has become chiefly associated with this type. It is, however, used loosely on this continent for almost any muskmelon, except the large types and for the Honey Dew type which itself possesses an attractive name. The true cantaloupe of Europe is practically unknown in America.

A.—Banana group. Fruit banana-shaped, 12 to 18 inches long, 4 to 5 inches across; flesh light salmon; banana-like flavour; late. The Banana variety is useful in Ontario only as a novelty.

B.—Jenny Lind group. Fruit small, flat, base and apex flattened and full; blossom scar conspicuous, often with prominent knob.

1. Green flesh: Jenny Lind.
2. Pink flesh: Fordhook.
3. Salmon yellow: Emerald Gem.

Jenny Lind is especially sweet in taste and is early enough for widespread planting but because of its green flesh it is not very popular. **Fordhook** is liked better, but, because of the small size, both are for the home garden only. **Emerald Gem** is a poor keeper but has the merit of earliness.

C.—Defender group. Fruit oblong, medium to large, ribbing irregular, netting moderate to absent; flesh salmon tinted; grown for home garden and local market: Burrell Gem, Ohio Sugar, Delicious, Osage (Miller Cream), Extra Early Osage, Golden Osage.

Delicious is probaby the most popular variety of the Defender group in Ontario. For its large size, it is early. It is essentially a local market variety and cannot compete with Hale's Best where shipping is concerned.

D.—Hoodoo group. Fruit moderately small, slightly elongated and nearly globular, heavily netted, moderately to finely laced; skin dark green; flesh pink: Paul Rose, Hearts of Gold (Hoodoo Improved).

Hearts of Gold is popular for local market in warm sites in the warmer districts of Western Ontario. It is later than Hale's best, and its shape is not as suitable for packing.

E.—Early Ripe group. Notably early, medium size, golden yellow flesh, ribs fairly prominent in most cases. Lake Champlain, Golden Champlain, Chipman Champlain, Farnorth. Not quite as early as the Earliest type (group N), but superior in other respects.

F.—Surprise group. Fruit moderately large, oval to nearly globular; netting sparse or medium, patchy, often streaked to evenly netted; skin light creamy yellow; cavity rather large; flesh salmon; medium early: Surprise, Bender Surprise, Irondequoit, Tip Top, Iroquois, Aristocrat, Oregon Delicious, Golden Marvel (Marvel), Oka, New York 1406, Schoens Hard Shell Bender, Perfect.

The Surprise group includes the best of the moderately large size muskmelons for use in southern Ontario. **Bender Surprise** (6 to 8 pounds) is popular for local market, as is **Delicious** (4 to 5 pounds) which is slightly earlier. **Schoens Hard Shell Bender** is a shipping form. **Oka** is grown to some extent on warm sites in eastern Ontario where it is a delicious home garden variety. **Iroquois** is resistant to fusarium wilt. It is a leading commercial variety in the southwestern section of western Ontario as throughout this area wilt has been destroying 10 to 30 percent of the crop of other varieties. Another important variety in this section is one known locally as **Perfect.** It is superior to Iroquois in flavour and appearance but not in resistance to wilt.

G.—Honey Rock group. Fruit round to almost so, medium size; flesh pink with a tough, hard rind; netting distinctive, coarse, heavier than that on most melons; midseason: Honey Rock (Sugar Rock), Michigan 4054, Michigan 4057, Granite State.

Honey Rock (2½ to 3 pounds) is slightly earlier than Bender Surprise. It is of good quality and is liked for local market. **Granite State** is not quite as prominently netted as Honey Rock but in all other respects it is similar in fruit characteristics. It was introduced as an early Honey Rock type for New Hampshire conditions and may have special value in short-season districts in eastern and central Ontario.

H.—Netted Gem group. Fruit small, short oval, ribbed and well netted; sutures not netted over; flesh green, and in certain cases such as Knight the flesh blends from a light green to a salmon pink adjacent to the cavity; early; progenitor of Rocky Ford group: Early Watters, Bottomly, Early Imperial, Knight.

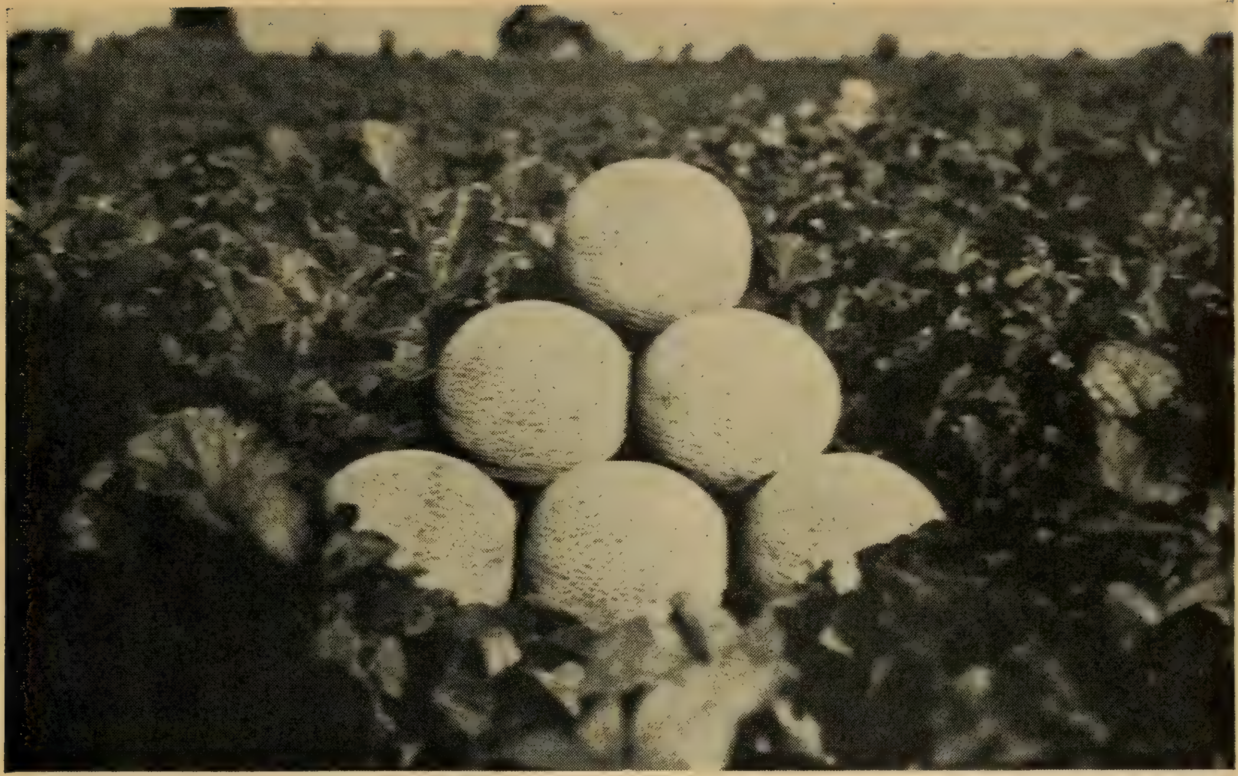


Fig. 30. Seed Breeders variety of cantaloupe or muskmelon.

Knight is the most popular green-fleshed muskmelon in Ontario. Excellent flavour. Green-fleshed melons are not liked on the market as well as those with pink or salmon flesh.

I.—Rocky Ford and Perfecto group. Fruit small to medium, rounded oval, not ribbed, heavily netted; sutures absent or shallow and well netted over; medium early to late in the case of the Perfecto type.

1. Green flesh: Gold-lined Rocky Ford, Eden Gem, Green-Meated Pollock, Netted Rock, Mission Bell.
2. Pink flesh: Golden Pollock, Rice Orange Fleshed, Perfecto, Superfecto, AZ, Perfected Perfecto.
3. Pink around cavity: Salmon Tint, Pollock 10-25, Gold-lined Pollock, 101 Special.

J.—Hale's Best group. Fruit globular, small to medium (2 to 2½ pounds), moderately ribbed, distinctly netted; seed cavity small to medium; flesh orange, medium to thick; midseason: Hale's Best, H. B. 36, H. B. 112, H. B. 936, Powdery Mildew Resistant 45 (as well as 5, 6, 7, and 8), H. B. Seed Breeders, Winner, Purdue 44, Texas Resistant No. 1, Mildew Resistant D-2, Jumbo Hale's Best, Early May, Golden Gopher.

This is an important group for the market gardener. The fruits of **Hale's Best** are round or nearly so, as well as firm, and grade a high percentage of acceptable specimens where crating and shipping are concerned. **H. B. Seed Breeders** and **H. B. 36** are widely used strains; both are more uniform than the original. **H. B. 112** is round, **H. B. 936** is long, and **Jumbo Hale's Best** is a large-fruited strain. **Powdery Mildew Resistant Cantaloupe No. 5** has lately been supplanted by the more resistant forms No. 5, No. 6, and No. 7; No. 5 is rated especially high in eating quality. The 4-50 is an improved strain of No. 45. **Mildew Resistant D-2** is larger and earlier than No. 45. **Early May** is one of the earliest strains of Hale's Best. **Texas Resistant No. 1** is a cross of the West Indian melon, Rocky Dew Green Flesh and Seed Breeders. The flesh is salmon coloured, fine textured, and with a sweet, spicy flavour. It is as early as Hale's

Best and is resistant to both downy mildew and aphids. **Purdue 44** is not resistant to bacterial wilt but is resistant to *alternaria* leaf spot. **Golden Gopher** fruit is larger than Hale's Best and less netted. It is earlier and resistant to fusarium wilt. It has stood up well under Ontario conditions.

K.—Hackensack group. Fruit large, flat; prominent ribs; heavy, coarse netting; sutures smooth, medium deep; midseason.

1. Green flesh: Large Hackensack, Montreal Market, Milwaukee Market, Baltimore Market, Extra Early Hackensack, Long Island Beauty.
2. Pink flesh: Greely Wonder, Indiana.

L.—Weaver group. Fruit round to oval; skin white, flesh orange; noted for fine flavour and smooth flesh: Weaver Special, Golden Globe, Pride of Wisconsin (Market King, Queen of Colorado). The late-maturing varieties in this group, such as Weaver Special, need intense heat in order to ripen.

An approximation to this group is **Honey Gold** which was introduced in 1941 by Edward Lowden of Hamilton. It ripens in the warmer districts. **Pride of Wisconsin** does well in the warmer districts of Ontario and is an excellent variety in favourable years, but the melons are subject to cracking at the blossom end during wet years.

M.—Winter types. Very late; requiring a very long growing season.

1. *Honey Dew group.* White exterior colour, ripening to a light cream; flesh green: Honey Dew, Honey Ball, Powdery Mildew Resistant Honeydew No. 60, Golden Honeymoon (Golden Rind Honey Dew).

Varieties in this group are adapted only to the warmest sections of Ontario.

2. *Persian group.* Large, nearly globular (7-10 inches), without ribs, profusely and uniformly covered with a light, moderately broad netting; flesh very thick, pink, fine textured, and, when properly harvested and stored, with a good flavour and distinctly pleasant aroma; skin, at the partial slip stage, yellow or slightly red; skin of fruits picked for long shipments, however, moderately dark green; of chief importance in the hot valleys of southern and central California and in Arizona: Persian, Baby Persian, Turkish, Oro Blanco.

Ora Blanco is the earliest of this group, but is too late for all but the most favoured sites.

3. *Casaba group.* Fruit large, oblate-oval, or short pyriform in shape, lemon-yellow in skin colour, tough skinned, not netted or ribbed, but profusely marked with longitudinal corrugations or deep wrinkles; flesh very thick, nearly white, juicy, without aroma, sweet, and of good quality when properly ripened; suitable for culture only in parts of California and the Southwest: Golden Beauty, Golden Hybrid, Crenshaw.

N.—Earliest type. Of exceptionally early maturity; fruit small, soft: Edible Gold, Arctic Sweets, Northern Honeysweet, Zephyr.

OKRA

The okra plant is very tender to frost, grows best in hot weather, and requires a long growing season with warm nights. The pods are the edible portion.

Okra may be classified into tall, dwarf, and ladyfinger types, and further into long and short pods. The earliest variety, an important consideration, is **Dwarf Green Long Pod.** Some later varieties are **Perkins Mammoth** (Tall Green) which is used for canning, and three spineless types **Clemson Spineless, Louisiana White Velvet** (Lady Finger), and **Perkins Spineless.** The latter was developed by the Campbell Soup Co. and is possibly the best type for processing in western Ontario.

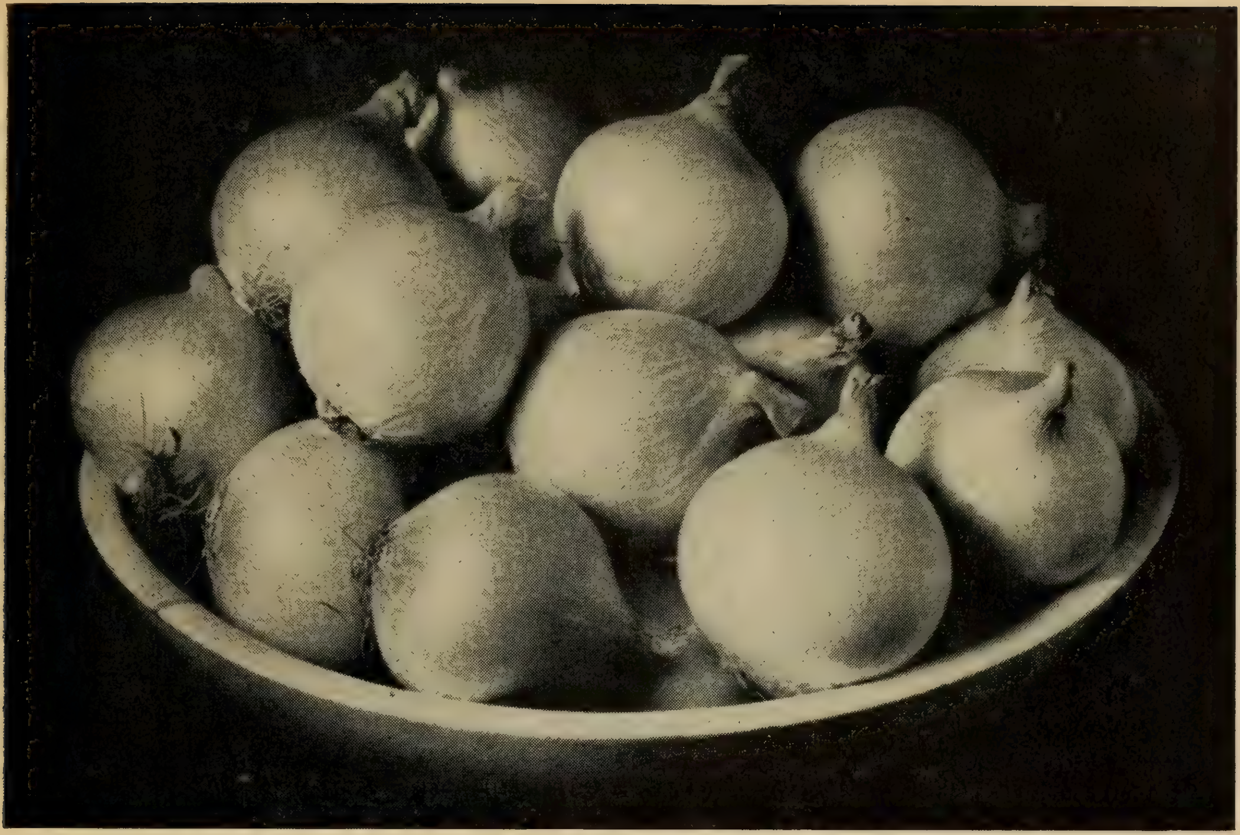


Fig. 31. Early Yellow Globe onion.

ONION

The onion bulb is made up chiefly of fleshy leaves, and the green leaves appearing above the ground are extensions of the swollen bases of some of these. Hence, though the onion produces a bulb, it is essentially a leaf vegetable. Its leafy character also separates it from the root crops.

Besides the bulb onions which are propagated from seed, there are a number of distinct types and these are set forth in the classification which follows.

1. Propagated from seed and grown as annuals.
A. Dry bulb scales brown: Australian Brown.
AA. Dry bulb scales yellow
B. Thick flat to medium oblate: Ebenezer.
BB. Not thick flat to medium oblate
C. Deep Oblate.
D. Scales light to medium yellow: Early Yellow Globe, Yellow Globe Danvers 11, 33, and 55.
DD. Scales medium brownish-yellow: Mountain Danvers.
CC. Not Deep Oblate
D. Base flattened: Ohio Yellow Globe.
DD. Base not flattened
E. Flattened upper half: Early Grano.
EE. Round or oval
F. Round: Yellow Globe Danvers, Yellow Globe Danvers 22 and 44.
FF. Oval
G. Medium Size
H. Scales medium yellow and medium thick: Southport Yellow Globe.
HH. Scales deep yellow and thick: Brigham Yellow Globe.
GG. Large, scales brownish yellow, flavour mild: Sweet Spanish.
AAA. Dry bulb scales white
B. Oblate: White Portugal, White Ebenezer.
BB. Deep Oblate to round

C. Medium size, strong flavour: Southport White Globe.
CC. Large size, mild flavour: White Sweet Spanish.
AAAA. Dry bulb scales red or purple
C. Thick flat: Red Wethersfield.
CC. Round to oval: Southport Red Globe.

Note: Besides these there are many minor ones and numerous English varieties, such as Ailsa Craig, Bedfordshire Champion, Excelsior, Cranston Excelsior, and James Keeping.

2. Propagated from seed and grown as a hardy perennial or winter annual, or increased by division. Not bulb forming; used as a very early bunching onion; often called cibol: White Welsh, Japanese Bunching, Nebuka.
3. Propagated by division. No top sets or seed; increased by division, splitting, or branching of the "bulbs" at the base of the plant into "bulblets"; not so hardy as White Welsh or Egyptian, but sometimes winters successfully: Yellow, Red, and White Multiplier.
4. Propagated by top sets. Sets (little bulbs or bulbels) produced in clusters on top of the plant in place of flower umbels, removed from the stalk, and planted in the fall for the production of green onions the next spring; the bottom also divisible; perennial; winter hardy; adapted to forcing in a greenhouse in winter: Egyptian or Perennial Tree Onion.
5. Shallot. The name "shallot" is often loosely used for any green bunch onion, and particularly the multiplier type. The shallot bulb, when planted, divides into a cluster of 2 to 20 cloves which are attached at the bottom. There are two commercial types of Louisiana shallots, namely the pin-leaved and flat-leaved: Louisiana Pearl, Louisiana Evergreen (Pearl x Nebuka).

Ebenezer provides most of the yellow sets, as it makes nearly round, bright yellowish-buff ones of good keeping qualities. To a moderate extent it is grown from seed for storage. Not well liked on marsh land when grown to full size because many of the flat bulbs go through the grader thus reducing the percentage grading as No. 1, and the market demands a more globular variety.

The bulbs of **Mountain Danvers** are round to slightly flattened globe shaped, medium pungent, with brownish-yellow dry skins. A fault on marsh land is that the bulbs do not become sufficiently hard at the neck and rots frequently occur.

Early Yellow Globe is characterized by medium-size, slightly flattened, globe-shaped bulbs and medium-pungent flesh; the medium-yellow scales are fairly well retained during handling and storage. On marsh land, it is liked for its earliness, high yield, and fair keeping quality. Some drawbacks are that the skin colour often is greenish yellow and the shape and size are not as uniform as could be desired.

Brigham Yellow Globe (Michigan Yellow Globe) is noted for its small neck, tough skin, deep bronze yellow skin colour, uniformity in shape and size, and keeping quality when grown on marsh land.

Yellow Globe Danvers, particularly strain No. 11, is an outstanding keeper, and is good with respect to uniformity in shape, size, and colour. But, it is only of medium size and does not yield as heavily as Early Yellow Globe. **Yellow Globe Danvers 22 and 44** are similar in both form and season maturity. In both cases the bulbs are large in size and late in maturity. Many of the bulbs are deep in form and similar to large-sized bulbs of Southport Yellow Globe in type. No. 22 is seldom sown in Ontario, although it is excellent for long season sites. No. 44 is the most popular variety in southwestern Ontario from the market garden standpoint. It is recognized as the best Yellow Globe Danvers stock obtainable at the present time. It is too late to succeed in eastern or

Fig. 32. Bulbs used to produce Foundation seed of Yellow Globe Danvers 44 onion.

central Ontario. Another stock that is doing especially well in southwestern Ontario is **Yellow Globe Danvers 55.** It is earlier than No. 44, flatter in form, and slightly smaller in size, although the average bulb is very large and attractive. This stock is sown by onion experts who wish to harvest a crop which is slightly earlier than No. 44. **Yellow Globe Danvers 33** is not grown to any extent in Ontario. The bulbs range all the way from those which are approximately flat to those which are deep in form. It is a heavy yielding stock, with large-sized bulbs that are late in maturity.

Southport Yellow Globe is late-maturing and productive and, when properly matured, keeps well in storage.

White Portugal (Silverskin) is widely used for white sets and picklers as the small sets are nearly round. **White Ebenezer** is also extensively used for sets; it resembles White Portugal but the tops are somewhat stronger. **Barletta** is somewhat earlier and smaller.

Southport White Globe is the most popular white variety for storage. Clean bulbs in good condition are difficult to produce because the white colour is easily spoiled by sunburn, greening, or soil discolouration. This variety is widely used for the production of green bunch onions from seed, as less skinning is required to produce the desired white bulb or basal swelling. It is well adapted for dehydration and manufacturing purposes because of its high dry-matter content, lack of objectionable colour, and high flavour or pungency.

Red Wethersfield is a productive and excellent storage variety with thick flat bulbs when mature. Most red onion sets are of this variety. There is discrimination against the red colour of mature bulbs. The bulbs of **Southport Red Globe** are medium size, round to oval, late, and keep well when mature.

Sweet Spanish (Valencia) is not a long-storage variety. Greatly esteemed for salads because of its succulent, sweet, mild-flavoured, almost white flesh, it has large, round or slightly oval bulbs, with brown-yellow dry scales. The Utah strain is more uniform and better coloured than most other strains of Sweet Spanish. **White Sweet Spanish** is slightly earlier and of same shape or somewhat flatter than Sweet Spanish with clear-white outer scales.

Early Grano is also sold as Babosa, Earliest Express, and Early Sweet Spanish. It is one of the mildest flavoured of all onions, but does not keep well in storage. From the home garden standpoint, it is preferred for northern Ontario in place of Sweet Spanish as it is earlier. There is also a White Grano.

PARSLEY

Parsley is probably the most widely grown garden herb.

Moss Curled (Champion) is slightly earlier and faster growing than **Paramount** but the latter is a fine, dark green, curled strain; both are of the triple-moss-curled type. **Evergreen** is less finely cut, but is a heavy yielder and seems somewhat more resistant to frost and drought.

PARSNIP

Parsnip seed soon loses its vitality, and so seed not over a year old should be used.

A.—Roots long (12 to 24 inches). Crown depressed or with high shoulder: Hollow Crown (All American, Model, Champion, Success, Long Smooth, Maltese, Goliath).

B.—Roots medium long (10 to 15 inches). Crown rounded: Guernsey (Half Long), Student, Offenham, Syston Intermediate.

C.—Roots short (6 to 8 inches). Crown full and rounded: Short Thick.

D.—Roots rounded (3 to 4 inches deep). Crown full and rounded: Early Short Round.

Hollow Crown probably represents 75 percent of all plantings. It is 12 to 20 inches long, measures about 2½ to 3 inches across the characteristically depressed or hollow crown, and tapers gradually to a slender point. The **Model** strain is well liked on marsh land where the roots are notably smooth with a minimum of branching and the skin is unusually white. **Guernsey** is shorter and stouter, the crown is full rounded, and the roots are easier to harvest. These are the two chief main-crop and storage varieties. **Offenham** and **Syston Intermediate** are improved medium-long British stocks. **Short Thick** is at least 2 weeks earlier than Hollow Crown, measures 6 to 8 x 2½ to 3½ inches, and is comparatively easy to pull.

PEA

Dr. W. L. Wade, U. S. Department of Agriculture, has prepared a key which aids in the identification of pea varieties. This key is expanded in this bulletin to include more varieties. The key specifies the node of first bloom, and so indicates the earliness of a variety; for example, a variety that blooms at the 8th node is earlier than one whose first flower is found at the 16th node. In general, also, varieties that begin to bloom at the 8th to 14th node are less variable than those that bloom first at the 15th to the 24th node. Those that begin to bloom at the

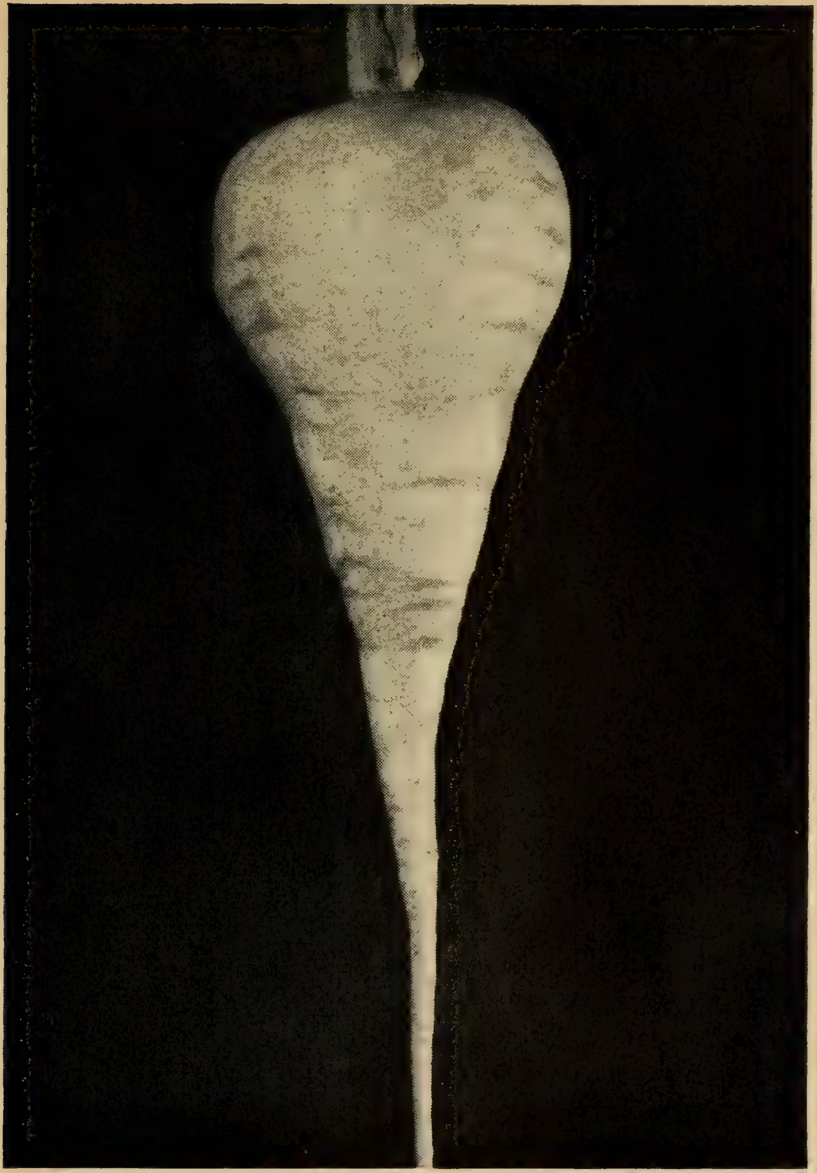


Fig. 33. Short Thick parsnip.

8th to 14th node in most cases will eventually have two pods per node. This heavy concentration of pods causes a dwarf or determinate type of vine which tends to be hardy and to stand up under, or adjust itself to, adverse conditions. Because the determinate types are uniform and with a heavy concentration of pods which do not vary greatly in maturity they are favoured by canning companies. Canning types are seldom used in freezing. The best varieties for freezing are found in the groups with dark green peas. These types begin to bloom past the 14th node, and the pods are large, handsome and borne singly. The vines are long, indeterminate, are subject to damage from changes in climate, show more variation in maturity of peas, and the top pods may be in the flat stage while the lower pods are mature.

One might expect that the market gardener would grow chiefly the indeterminate varieties, rich in colour and sugar, and with large, handsome, market-type pods. This is not always the case. Often his main hope of making maximum profit is to pick as many pods as possible early in the season, and therefore he may at times grow varieties specified in this bulletin as canning types.

KEY TO PEA VARIETIES

	Wilt reaction	*Node of first bloom*	*Variety*
A. Early, beginning to bloom at the eighth to the twelfth node.			
B. Vines tall and weak (internodes straight).			
C. Seeds smooth or dimpled, green.			
D. Pods small.			
E. Pods blunt.			
F. Foliage light green	Susceptible	8 or 9	Alaska
	Resistant	8 to 11	Alaska (various wilt-resistant strains such as Alah and Yukon).
	Susceptible	8 or 9	Winner.
DD. Pods of medium size.			
E. Pods. blunt.			
FF. Foliage medium to dark green	Resistant or susceptible	9 or 10	Ameer (Claudit).
EE. Pods pointed.			
FF. Foliage medium to dark green	Susceptible	9 or 10	Bountiful.
CC. Seeds smooth or dimpled, yellow.			
D. Pods small.			
E. Pods blunt.			
F. Foliage light green.	Resistant or susceptible	8 or 9	Extra Early.
	Susceptible	9 or 10	First and Best (Pedigree Extra Early).
FF. Foliage dark green	Resistant	9 or 10	Idaho White.
EE. Pods pointed.			
FF. Foliage medium to dark green	Susceptible or resistant	10	Market Surprise.
CCC. Seeds wrinkled, green or cream and green.			
D. Pods small.			
E. Pods blunt.			
F. Foliage light green	Susceptible	8 or 9	Surprise.
	Resistant	8 or 9	Peerless.
	do	8 or 9	Wisconsin Early Sweet.
	do	8 or 9	Mardelah.
	do	8 or 9	Resistant Surprise (Surpass).
	do	8 or 9	AA 15.
	do	9 or 10	Early Harvest.
DD. Pods of medium size.			
E. Pods blunt.			
FF. Foliage medium to dark green	Susceptible	9 or 10	Thomas Laxton.
	Resistant	9 or 10	Glacier.
EE. Pods pointed.			
F. Foliage medium to dark green	Resistant	9	Cody.
	Susceptible	10 or 11	Gradus (Prosperity).
	Resistant	10 or 11	Gradah.
	Susceptible	11 or 12	Improved Gradus (Frostie).
FF. Foliage light green	Resistant or Susceptible	9 or 10	World Record.
	do	9 or 10	Stella (Easy Money).
BB. Vines short and sturdy (internodes zigzag).			
C. Seeds smooth or dimpled, green.			
D. Pods small.			
E. Pods blunt.			
F. Foliage light green	Susceptible		Petit Pois (Tiny).
DDD. Pods large.			
EE. Pods pointed.			
F. Foliage light green	Susceptible	10	Laxton Superb.
CCC. Seeds wrinkled, green or cream and green.			
D. Pods small.			
E. Pods blunt.			
F. Foliage light green	do	10	Nott Excelsior.
FF. Foliage medium to dark green	do	9	American Wonder.
	do	10	Early Badger.
	do	10	Little Marvel.
	do	10	Little Gem (Premium Gem, Premier, McLean's Gem).
	do	10	Giant Wonder.
	Resistant	10	Premium Gem Improved.
DDD. Pods large.			
E. Pods blunt.			
FF. Foliage medium to dark green	Resistant	12	Morse Market.
EE. Pods pointed.			
F. Foliage light green	Susceptible	9	Peter Pan.
	do	10	Laxtonian (Blue Bantam).
FF. Foliage medium to dark green	do	10	Pioneer.
	do	10	Hundredfold.
	do	10 or 11	Multifold.
	do	9	Laxton's Progress.
	Resistant	9	Resistant Progress.
	do	12	President Wilson.
AA. Midseason, beginning to bloom at the thirteenth to the twenty-fourth node.			
B. Vines tall and weak (internodes straight).			
CC. Seeds smooth or dimpled, yellow.			
D. Pods small.			
E. Pods blunt.			
FF. Foliage medium to dark green	Unknown	13 to 21	Creole.
CCC. Seeds wrinkled, green or cream and green.			

KEY TO PEA VARIETIES— Contd.

D.	Pods small.			
E.	Pods blunt.			
FF.	Foliage medium to dark green	Resistant	13	Kay (Early Kay).
		Susceptible	13	Chief.
		Resistant	13	Teton.
		do	14	Champion of England.
		do	14 or 15	Green Admiral.
		do	14	Climax.
		do	16 to 18	Yellow Admiral.
DDD.	Pods large.			
EE.	Pods pointed.	do	13 to 14	S219.
F.	Foliage light green	do	14 to 16	Tall Telephone.
FF.	Foliage medium to dark green	do	13	Early Alderman.
		Susceptible	14	Miracle.
		Resistant	14 to 16	Alderman (Dark Podded Telephone, Prince Edward, Prodigious).
		do	14	Kent Alderman.
		do	14 to 16	VC.
		do	14 to 16	Quite Content.
		do	14 to 16	Aldermah.
BB.	Vines short and sturdy (internodes zigzag).			
C.	Seeds smooth or dimpled, green.			
D.	Pods small.			
E.	Pods blunt.			
FF.	Foliage medium to dark green	Resistant	18 to 24	Bluebell.
DDD.	Pods large.			
E.	Pods blunt.			
FF.	Foliage medium to dark green	do	14 to 16	Pride of the Market.
CC.	Seeds smooth or dimpled, yellow.			
D.	Pods small.			
E.	Pods blunt.			
FF.	Foliage medium to dark green	do	18 to 24	Belle of Georgia.
CCC.	Seeds wrinkled, green or cream and green.			
D.	Pods small.			
E.	Pods blunt.			
FF.	Foliage medium to dark green	Resistant or susceptible	13	Abundance.
		Resistant	14	Horal.
DD.	Pods of medium size.			
E.	Pods blunt.			
F.	Foliage light green	do	13	Canner King (Asgrow).
		Susceptible	14	Onward.
FF.	Foliage medium to dark green	do	13	Early Perfection (Hardy).
		Resistant	13	Early Perfectah.
		do	13	Pride.
		Susceptible or resistant	14	Perfection (Advancer).
		Susceptible	14 to 15	Wando.
		Resistant	15 to 16	Everbearing (Bliss Everbearing).
		do	14 to 16	Merit.
		do	14	Shasta.
		do	15	Multnomah.
		do	15	Profusion.
		Susceptible	16	Horsford's Market Garden.
		do	16	Gallatan (Late Perfection).
		Susceptible	16	Delwiche Commando (Commando).
		Resistant	17	Signal.
		do	18	Major.
		do	18	Mammoth Green.
		do	16 to 18	Prince of Wales (Green Giant).
		do	16 to 18	Perfected Wales.
		do	16 to 17	Walah.
		do	18	Wisconsin Merit.
EE.	Pods pointed.			
F.	Foliage light green	do	17	Lincoln (Homesteader, Greenfeast).
DDD.	Pods large.			
EE.	Pods pointed.			
F.	Foliage light green	Resistant or susceptible	14	Carters Daisy (Dwarf Telephone).
		Resistant	14	Pacific Market.
		do	15	Dwarf Telah.
		Resistant	13 to 15	Senator.
		do	14	Phenomenon.
FF.	Foliage medium to dark green	do	15	Dwarf Alderman.
		do	16	Stratagem.
		do	16	Improved Stratagem.
		do	13	Gilbo.
		do	14	Giant Stride.
		do	14	Morse's No. 60.
		do	14	No. 40 (Asgrow).
		do	14	Stridah.
		do	15	Icer (No. 95).
		do	16	Stratah.

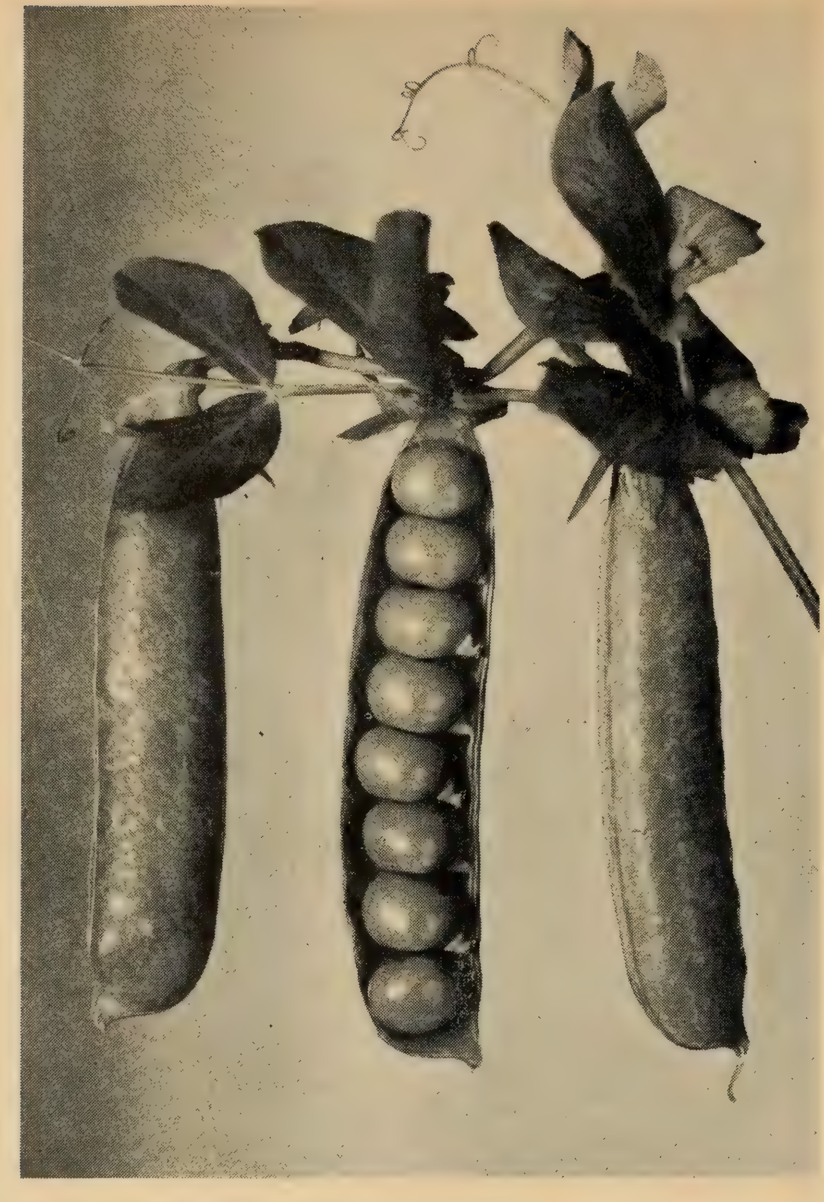


Fig. 34. Glacier pea.

Home and Market Garden Peas

Although the quality of **Laxton Superb** is only fair, market gardeners use it extensively for early sowing. **Progress** (Laxton Progress) bears large, attractive pods, and is popular for shipping, trucking, and for home and market gardens, but is susceptible to fusarium wilt; **Resistant Progress** is a resistant form. **World Record** is of fair quality but is early, with large inflated handsome pods, and is often used by market gardeners for the early market.

Thos. Laxton is a good, but not wilt-resistant, early-midseason, wrinkled pea for general purposes. **Teton** and **Glacier** are improvements over ordinary strains of Thos. Laxton. **Climax** and Teton are replacing **Kay** and **Green Admiral.** The pods of **Shasta** are dark-green and a little larger than those of Thos. Laxton though of similar shape. **Gradus** is similar in many respects to Thos. Laxton; **Gradah** is a wilt-resistant form. **Cody** and **Banqueter** resemble Gradus; the former is wilt-resistant and earlier than Gradus, and the latter is rounder podded. The dark green pods in both cases average 4 inches long. **Laxtonian** is usually a good producer and is

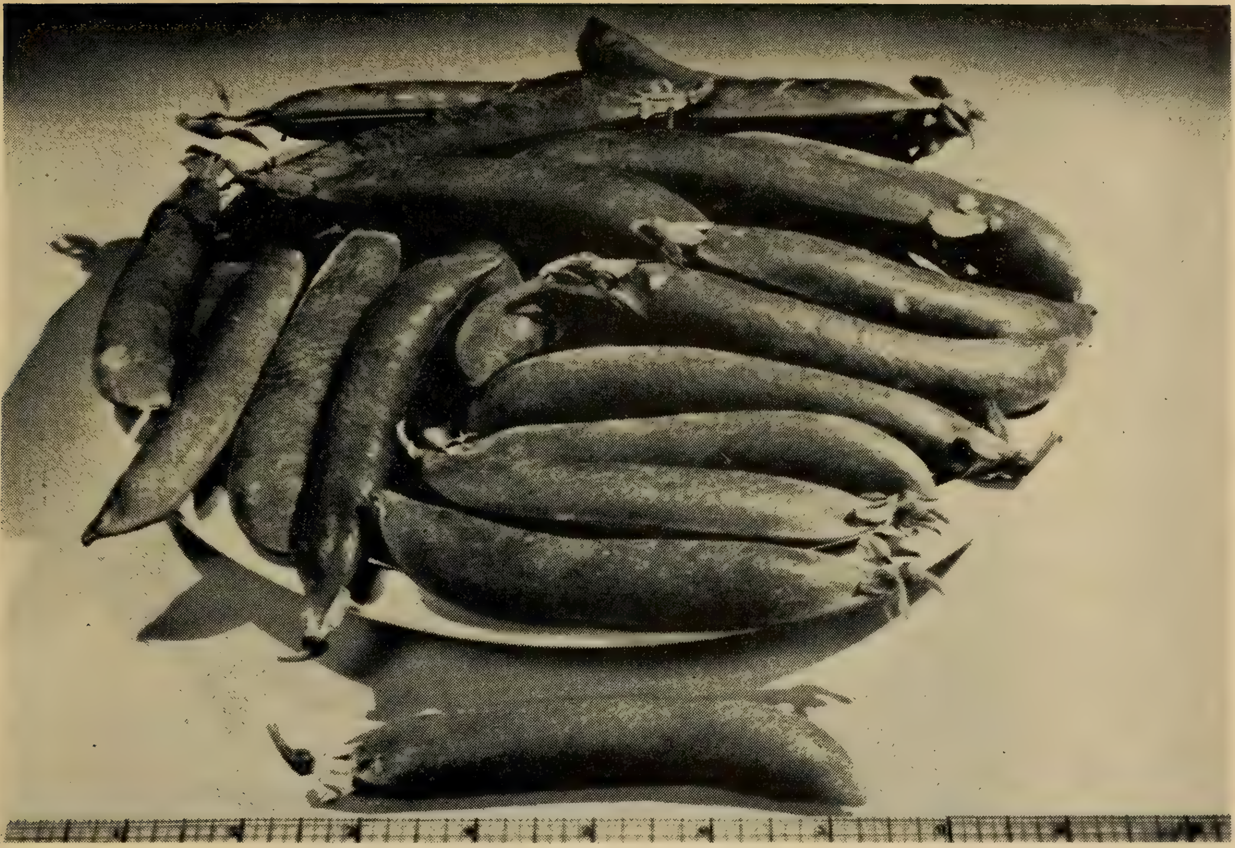


Fig. 35. Wyoming Wonder pea.

used by home gardeners, truckers, and shippers. **Peter Pan** resembles Laxtonian and at times is superior to it.

Morse Market is an excellent maincrop variety suitable for home garden use. **Hundredfold** is an attractive, long-podded, fairly early sort, for home gardens, for truckers, and for shipping. **Multifold** is a large Hundredfold type and is also useful for freezing. **Little Marvel, Improved Little Marvel, Little Gem** and **Premium Gem** are of high quality, yield well, and are desirable for home use and certain markets. **Everbearing** produces fairly well even under rather dry conditions.

Nott Excelsior and **Lincoln** (Homesteader) have been home garden favourites in Ontario for many years.

Telephone and the darker-podded **Alderman** are productive, large-podded, late, tall varieties, generally grown on supports. The inflated-pod members of the Alderman family, namely **Kent Alderman, V.C.,** and **Quite Content** have not become popular in Ontario but the peas are of high quality and remain tender for a comparatively long time. **Aldermah** is a more wilt resistant form. **Duke of Albany** is more vigorous than Telephone; it bears extra large seeds, is wilt-resistant, vigorous, and moderately productive.

Dwarf Alderman is used extensively by market gardeners for the late, high-class trade; plants stocky, branching, vigorous, and resistant to fusarium wilt; pods single and double, dark green, plump, pointed, and contain 7 to 9 large peas of good quality. **Dwarf Telephone** is late and popular with the home gardener as it has large, attractive, medium light-green pods with 8 to 10 large, sweet peas. **Dwarf Telah** is more disease resistant. **Innovation** and **Pacific Market** resemble Dwarf Telephone but are darker green and more attractive.

Stragatem, another late, sweet variety, is dwarfer in habit and with shorter, straighter, less-pointed pods than Dwarf Alderman. **Stratah**, a wilt-resistant form, is still later than Stratagem. **No. 40 (Asgrow)** is an early type Stratagem, adapted for shippers and market gardeners; its pods contain 8 to 10 large peas. **Improved Stratagem, Potlatch,** and **Dwarf Defiance** are late varieties with large handsome dark green pods. **Onward** is of excellent quality but is susceptible to fusarium wilt.

Giant Stride is the largest podded, large-seeded commercial variety, of fair quality, and is resistant to fusarium wilt. It is especially adapted for shipping and late market use. **Morse's No. 60,** an improved strain of Giant Stride, is resistant to fusarium wilt and slightly resistant to mosaic. **Wyoming Wonder** is resistant to fusarium wilt; pods large, and with dark-green peas. **Gilbo** is a good general-purpose, late variety resistant to fusarium wilt and that bears 8 to 9 large, good quality peas per pod.

There are a number of home and market garden types which have not been tested sufficiently by us to place in their proper section in the key. **Confidence** bears double, dark green pods with 6 to 8 large, dark-green peas per pod. **Giant Podded Hamper** produces dark-green vines with heavy foliage; the pods are pointed, dark, and the seed is large. **Sutton Excelsior** is productive and the pods are 3¼ inches long with 6 to 8 peas of good flavour.

Two comparatively drought resistant sorts are worthy of note, namely **Laxall** from the Central Experimental Farm, Ottawa, Ontario, and **Radium** from the Dominion Experimental Station, Prince George. B.C. The first is very hardy and is a dwarf, small-podded sweet form. Radium is taller and usually outyields Laxall except under dry conditions.

Commercial Canning Peas

The medium height of **Alaska** fits it well for the viner, and it is much used for canning. The green seed colour avoids too evident signs of over-maturity in the canned product. It retains its prominence as a canning variety largely because of its general thriftiness, and the canned product is popular in restaurants where a fairly tough product that remains firm after heating is desired. **Alah** and **Yukon** are forms of Alaska resistant to fusarium wilt; they are reliable croppers under fairly adverse conditions. **Bountiful** is a large podded Alaska, but with a pointed pod. **Winner** is useful for canning small sizes. **Horal** is resistant to fusarium wilt and leaf-spot, and in some degree to root rot, the pods contain more and smaller peas than Alaska, the colour is better, and the erect habit and top podding are advantages in harvesting. **AA15** is an early sweet type similar in colour to Alaska, but preferable to it in the pack. **Mardelah** is resistant to fusarium wilt, is as hardy and early as Alaska, and is superior to it in canning quality and colour. **Superalaska** is more vigorous but less uniform than Alaska.

Green Admiral produces more small sizes than the larger-seeded, sweet canning varieties, but, like **Yellow Admiral,** has largely passed out of the canning picture.

Surprise is an early, sweet canning sort, but yields are often only moderate. **Resistant Surprise** tends to be more vigorous. **Wisconsin Early**

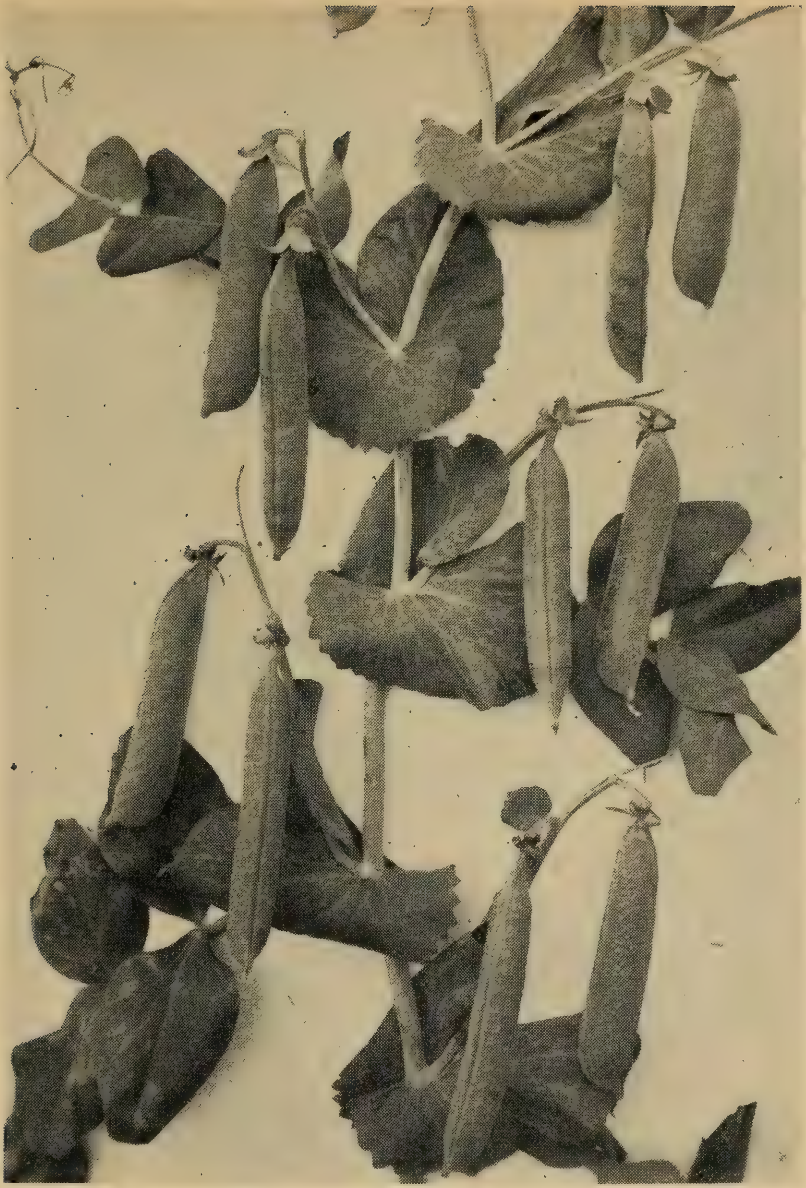


Fig. 36. Victory Freezer pea.

Sweet is fusarium-wilt resistant, and possesses much of the Surprise quality and the Alaska yielding ability.

Early Badger is of a desirable determinate growth habit, and the vines are stocky and do not lodge so readily as those of most early varieties, and the peas mature evenly. It ripens about the same time as Wisconsin Early Sweet and is a desirable pea to can as "ungraded sweet". **First and Best** is used chiefly as an early home garden pea, but it also can be used as a commercial dry pea. **Idaho White** resembles First and Best and is useful for whole peas or yellow split peas.

American Wonder is early, small, and of fine quality, but it is susceptible to fusarium wilt. **Giant Wonder** is a large-podded form of American Wonder for home gardens. **Witham Wonder, Kelvedon Wonder, Fenland Wonder** and **English Wonder** resemble American Wonder in season and type.

Perfection (Advancer) is a high producer of fair-quality canning peas. It is one of the chief main crop canning varieties; vine stocky; pods double, medium green, contain 7 to 9 peas which process semi-round and medium green; sieve size in canning mainly 3 to 5. **Perfection Resistant** and **Wisconsin Perfection Resistant** are leading canning strains. **Pride** is a Perfection type, is wilt resistant, highly productive, and concentrated in season. **Delwiche Commando** has been introduced to replace Perfection in areas where both fusarium and near wilt are present, and **Early Perfectah** is a hardy form resistant to fusarium wilt only. **Multnomah** and **Merit** are wilt resistant forms of Perfection; the former is early, and the latter is late and of excellent flavour. **Canner King** is more open in growth habit than Perfection and is resistant to fusarium wilt; its canning sieve sizes are large. **Wando** resembles Perfection in vine habit and is comparatively resistant to cold during the bloom and filling periods; the dark green seeds are attractive. Though it does not appear quite so well in the field, **Abundance** resembles Perfection in the can, and under adverse conditions may stand up better. It is not strongly resistant to disease and often suffers from drought because of its lateness.

Horsford's Market Garden is heavy yielding for canning but lacks the quality of Perfection or Gallatin (Late Perfection).

Prince of Wales ("Green Giant") is canned largely because of its large seeds of high quality. **Walah** is a disease resistant form with cream-coloured seeds. **Major** is late and large-seeded; the peas are bright green and more attractive than Prince of Wales. **Mammoth Green** and **Perfected Wales** are improved forms of Prince of Wales.

The standard canning varieties at present being used in Ontario are **Alaska, Little Marvel, Wisconsin Early Sweet, Thos. Laxton, Perfection,** and **Prince of Wales.** The Central Experimental Farm, Ottawa, suggests that Alton deserves trial to replace Thos. Laxton for canning, and Engress, which stands up well under dry conditions, to replace Perfection or Prince of Wales. **Tiny** is useful for the canning of very small peas.

A brief summary follows on commercial canning types which we have not yet given a complete test. **Ace** and **Alaska Sweet** or **Alsweets** (Rocket) are early types, the later being resistant to fusarium wilt. **Bonneville** bears medium-sized green seed, and is resistant to fusarium wilt. **Bridger** is an early Perfection type with dark-green vigorous vines; pods blunt, tightly filled, borne doubly, and with medium-sized green seed. The **Delicious** vine is dwarf with dark green heavy foliage; pods light green, semi-ballooned, with medium-sized seed. **Early Sweet #103** produces small sized siftings; pods straight, blunt, light green, and borne singly. **Famous** has medium dark green heavy foliage and light green pods. **No. 71 (Asgrow)** is heavy yielding; sieve sizes are 2 to 5; wrinkled, green seed. **Wisconsin Penin** is heavy yielding and wilt resistant; pods straight, 3½ inches long, maturing uniformly; seed medium large, green. **Wyola** is a heavy-yielding, wilt-resistant strain producing dark green, double, blunt pods. Peas small, dark green.

Peas for Freezing

Suitable varieties for freezing include Alderman (except in small sizes), Banqueter, Gradus, Improved Gradus (Frostie), Cody, Icer, Glacier, Laxtonian, Progress, Multifold, Shasta, Stragatem, Stratah, Improved Stratagem (Potlatch, Dwarf Defiance), Teton, Thos. Laxton (dark-podded strain), S219 (Miracle), Confidence, and World's Record.

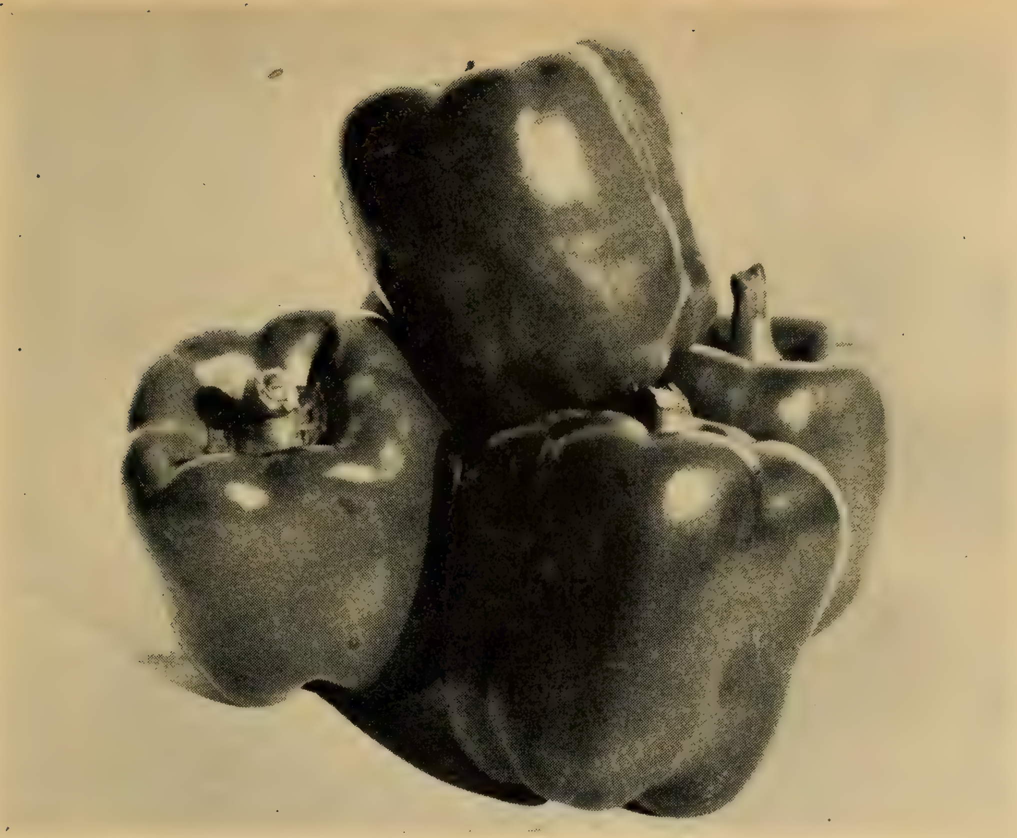


Fig. 37. Oakview Wonder pepper.

Thos. Laxton is probably the leading variety for freezing. **Montana Monarch** is being used in the west for canning, freezing, and market, and may have value for freezing in Ontario. Alaska, Horsford, Surprise, Giant Stride, and Wisconsin Early Sweet are only fair-to-poor varieties for freezing.

In 1947 at least five varieties, namely **Victory Freezer, Bonner, Oneida, Navajo,** and **Freezonian** were introduced as kinds especially adapted to freezing. They are said to be dwarf to semi-dwarf hardy types, resistant to fusarium wilt. Victory Freezer and Bonner are like Perfection in vine type with dark-green pods, borne in pairs. Oneida and Navajo bear dark-green attractive pods up to 4 inches long in pairs; they also are good for the home garden. Freezonian is a semi-dwarf Thomas Laxton type with comparative freedom from rabbit-ear rogues or skeleton vines. It is useful for both freezing and the home garden.

Edible-Podded Peas

Edible-podded peas are of little importance in Ontario. Those who are skilled in preparing edible-podded peas pick and prepare them like snap beans before the seed develops to full maturity. **Dwarf Gray Sugar,** and **Dwarf White Sugar** are semi-tall and small-podded. **Mammoth Luscious Sugar** is a long-vined type. The leading variety in Ontario is **Mammoth Melting Sugar.** The vines average 54 inches in height, but are often grown without support. The large pods are very broad, brittle, fleshy, stringless, free from fibre, and 5 inches long. **Paramount** is a large-podded, thick-fleshed variety and is the choicest of all edible-podded types. It should be grown on a trellis. The seed of Paramount has largely been imported from Holland.

Soup Peas

Eastern Ontario is noted for its soup peas. The leading variety is **Arthur. O.A.C. No. 181** is gaining in popularity as it shows resistance to *ascochyta* disease. **Chancellor** (Dashaway) is used to a lesser extent.

Borderline Types of Peas

Bluebell is a field pea that has occasionally been canned. Similar types are **Blue Prussian, Idabell,** and **Early Blue.** These are on the borderline where table use is concerned but sometimes are picked for this purpose. Early Blue is commonly grown for the split pea trade. **Extra Early** and **First and Best** are closely related types. They are much more important for dry edible peas than for market garden use. **White Canada** is grown for the split pea trade, and **Idaho White** can be used as a yellow split type.

PEPPERS

There are two general classes: (a) mild — used for salads, pickles, baking, and stuffing; (b) hot — used for relishes, seasoning, and sauces. Both of these are very distinct from the black and white peppers of commerce which are derived from the fruit of *Piper nigrum,* a tropical woody plant. Cayenne or red pepper is the dry fruit of small, pungent, or chili varieties ground to fine powder. Pepper sauce of various kinds consists of the fruit of pungent varieties preserved in brine or vinegar. Tabasco sauce is the juice of very small, extremely pungent varieties, expressed by pressure. Paprika is made from the fruit of the long-podded, mild Hungarian type, ground after the seeds have been removed.

In many trade catalogues the anglicized term "pimento" is used to designate a variety with oblate fruit, such as varieties of the Tomato group; others list it for varieties with conical-shaped fruit of the Perfection group. To add further confusion, the Spanish term "pimiento", which means pepper, is also applied to allspice, a species of aromatic tree (pimental officinalis). The word "chili" is Spanish for any kind of pepper; but on the North American continent the term is limited to mildly pungent varieties used mostly in the dry state for flavouring other foods.

A.—Calyx embracing base of fruit or cup shaped.

1. Fruit linear and erect: *Tabasco or Chili group*—Cardinal, Chili Dwarf, Japanese Cluster, Orange Red Cluster, Red Chili, Tabasco.
2. Fruit elongated, conical, and pendent: *Cayenne group*—Anaheim Giant Chili, Heifer Horn, Hot Portugal, Long Red Cayenne, Long Red.

B.—Calyx pateriform or saucer shaped.

1. Fruit globose: *Cherry group*—Bird's Eye, Cherry, Creole, Red Cherry, Yellow Cherry.
2. Fruit conical.
   - (a) Fruits erect or upright: *Celestial group*—Coral Gem, Floral Gem, Little Gem, Spanish Gem, Prince of Wales.
   - (aa) Fruits pendent:
   - (b) Immature fruit green: *Perfection group*—Early Pimento, Perfection (Pimento), Hungarian Paprika.
   - (bb) Immature fruit yellow: *Banana group.*
   - (c) Sweet to slightly pungent: Roumanian, Sweet Banana, Hungarian Wax.
   - (cc) Pungent: Hungarian Yellow Wax, Banana (Long Hot Yellow).

3. Fruit oblate: *Tomato group*—Sunnybrook (Large Sweet Cheese, or Squash), Topepo, Red Apple.
4. Fruit blunt-ended and blocky: *Bell group*—The Bell peppers constitute the mangoes of commerce; these large-podded, sweet peppers are used either in the green or in the mature stage for stuffiing.
    (a) Mature fruit red: Bull Nose (Large Bell), California Wonder, Early California Wonder, Calwonder (Early Calwonder), Chinese Giant, Crimson Giant, Early Giant, Harris Wonder, Hamilton Market (hot), Harris Earliest, King of the North, Michigan Wonder, Oakview Wonder, Magnum Dulce, Merrimack, Neapolitan, Pennwonder, Royal King, Ruby King, Worldbeater (Ruby Giant), Waltham Beauty.
    (aa) Mature fruit yellow: Golden California Wonder, Golden Dawn, Golden Queen, Golden Wonder, Oshkosh (upright), Prolific Yellow.
5. Fruit intermediate to long conical, with blunt to pointed ends: *Extreme Bell group*—Windsor A.

California Wonder, which is smooth and thick-walled, is the most handsome of all pepper types, but it can be ripened successfully only in warm, long-season districts. In order that earlier types become available plant breeders have introduced earlier forms of the California Wonder type, the most valuable of these to the market gardener being **Oakview Wonder, Early California Wonder,** and **Early Calwonder.** Still earlier types with fruits much smaller than California Wonder, but with thick-fleshed fruits outstanding in quality are **Harris Wonder** and **Waltham Beauty.** These two are the best home garden sorts for Central Ontario. A type similar in season but not in form is **Windsor A.** Its fruits average 4 inches long and are often long pointed in form. The fruits will not stand on end when stuffed and are, therefore, cut lengthwise for stuffing.

Pimento peppers have been considered late for Ontario conditions, but **Early Pimento** is suited to the warmer sections.

Sunnybrook (Squash, Cheese) is a thick-fleshed type with short fruits which can be canned whole.

In short-season districts the earliest of all peppers sold commercially, namely, **Harris Earliest,** has been the most widely grown by home gardeners. It may shortly be superseded by **Merrimack Wonder** and **Pennwonder.** These are almost as early and are decidedly superior in thickness of flesh. The size of these two varieties is not too small for market garden use, and both can also be used for preserving or for pimentos.

Within recent years several forms of yellow sweet peppers have appeared. These can be ripened successfully only in the warmer sections of Ontario. Little known in Ontario and but an excellent sweet yellow-fleshed variety is the **Roumanian** or **Sweet Roumanian.** This is harvested at the waxy yellow stage. It later turns a brilliant red.

In hot peppers, the most popular varieties include **Hamilton Market, Long Red Cayenne,** and some members of the **Hungarian Yellow Wax** family.

POTATO

Since the potato is without decided flavour, it is disliked by few, and for this reason it is a food of which few persons tire, being in this respect much like bread. Few crops give a higher yield per acre than potatoes. Coloured varieties are only in very limited demand in Ontario.

Warba is very early. The tubers are roundish and white with deep red eyes. It tends to set too many tubers and to be rough. There is also a red-tubered strain.

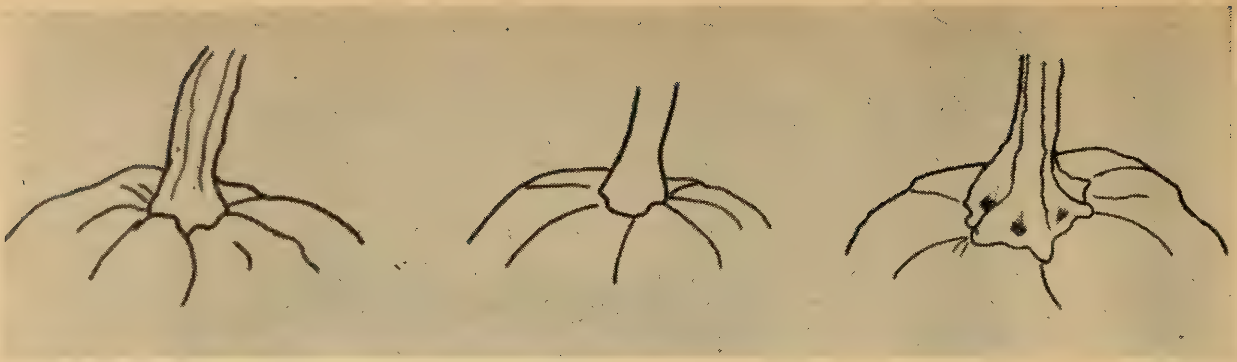


Fig. 38. Types of fruit stems. *Left to right: Cucurbita moschata, Cucurbita maxima* (winter squash), *Cucurbito Pepo* (pumpkin, summer squash, vegetable marrow.)

Early Ohio has long, pink tubers. It is a little better in quality than Irish Cobbler or Bliss Triumph but does not, under most conditions, yield as high. **Bliss Triumph** is early to medium. The tubers are red and cubical; the eyes at the stem end are rather deep. It is low in starch and not of particularly good quality.

The tubers of **Irish Cobbler** are spherical (often irregular), creamy white, comparatively high in starch, and uniform in quality. It tends to be deep eyed and rough on the heavier soils, and averages 4 to 8 tubers per hill. In southern Ontario it is grown only as an early crop and is harvested early in July. It is the leading midseason crop on marsh land.

Green Mountain is medium late; the tubers are oblong-flattened with blunt ends, the skin dull creamy white. It rates high in quality and stores well. However, it is quite susceptible to a number of diseases and insect pests, and tends to produce, especially on the heavier soils, a high proportion of off-type tubers.

Chippewa matures 2 to 3 weeks later than Irish Cobbler. The tubers are creamy white to dark cream buff, smooth, and oval to oblong in shape. The eyes are few and shallow. The tubers are very attractive, and fair in quality, and should be marketed early as they soon sprout in storage. It is the leading main crop variety on marsh land.

Katahdin is a leading main crop and storage variety on upland soils. As grown on marsh land, it is less flat than Chippewa, which is desirable, is a better cooker, and stores well. However, the underground stems spread so much that the digger misses a rather high proportion of the tubers and leaves them in the marsh.

Sebago is gaining in popularity as a late variety, especially in western Ontario. The tubers are white, and are longer than broad in form. It is heavy yielding, with plants that are both highly disease and insect resistant. The main drawback is that it takes about 135 days to bring it to full maturity in the warmer sections of Ontario. Therefore, it is too late for short-season districts, and even in the more favoured sections of the province early planting is essential.

Russet varieties, e.g., **Russet Burbank** (Netted Gem, Idaho Russet) and **Russet Rural**, even though more resistant to scab than are smooth varieties and are of good eating and storage qualities, rank comparatively low in popularity in Ontario.

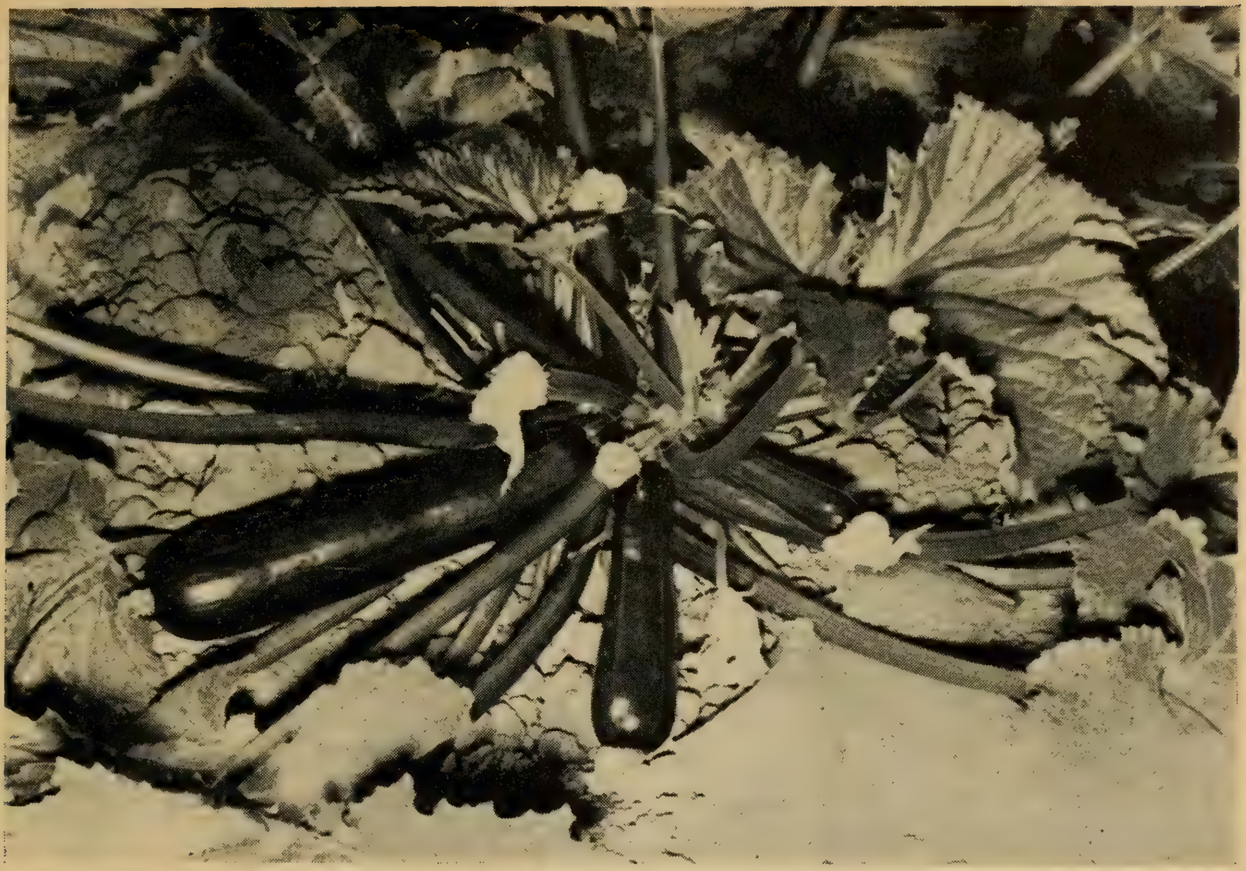


Fig. 39. Cozini variety of Italian vegetable marrow.

PUMPKIN, SQUASH, and VEGETABLE MARROW

Three different species are involved in the discussion of pumpkin, squash, and vegetable marrow varieties. One distinguishing feature between the three species is the type of fruit stem. The differences in this character, as well as others which are given, enable the rather numerous varieties to be arranged into the groups which follow.

A.—*Cucurbita maxima*, True Squash, Winter Squash. Vines rough, hairy, trailing; leaves rounded, kidney shaped, or slightly lobed, with naked basal veins; flowers with rounded lobes; fruit stem cylindrical or claviform, spongy, soft, not noticeably ridged or furrowed, enlarged at its attachment to the fruit; seeds large, enameled, usually bright solid white or brown; seed scar slanting; late; fruit easy to keep.

1. *Hubbard group.* Fruit spherical, tapering to a curved neck at stem end and to a somewhat curved point at blossom end: Hubbard, Kitchenette, Marblehead.
2. *Turban group.* Turban shape; button at the blossom end; often "a squash within a squash" at the blossom end. (a) Vine trailing—Sweetmeat, American Turban, Buttercup, Greengold; (b) Bush—(fruits clustered near the main stem) Bush Buttercup. The latter type is particularly useful for home gardens where space is limited.
3. *Boston Marrow group.* Fruit lemon shaped, light to reddish orange colour; surface irregular: Boston Marrow.
4. *Delicious group.* Fruit cone shaped (like a child's top): Delicious, Golden Delicious, Winnebago, Banquet.
5. *Banana group.* Fruit long, tapering at both ends; shell soft; colour greenish gray: Banana, Red Banana, Rainbow.
6. *Pebbled group.* Fruit with deep orange skin; shell very thick, hard, and extremely pebbled: Warren, Victor.
7. *Show or display group.* Very large, soft-shelled varieties:Mammoth, Mammoth Chili, Mammoth Whale, Etampes. These are novelties and may weigh 100 pounds.

Warted Hubbard is of excellent quality, a good keeper, and is the most popular of winter squash variety. Other good varieties of the Hubbard group are Green Hubbard and Golden Hubbard.

Buttercup and **Greengold** fruits are small (3 to 5 pounds), of high quality, and are good for baking in the half shell. They are early and of special value in short-season districts.

Boston Marrow is the most productive of the large, orange-fleshed varieties. It is only fair in quality but is almost without a shell, and so the whole squash may be ground up for pie filling, thus saving labour in preparation. Much of the canned "pumpkin" of commerce is prepared from Boston Marrow squash.

Delicious and **Golden Delicious** are of high quality. Most **Banana** strains are large in size and late. **Rainbow** is the earliest Banana type and is adapted to southern Ontario.

Novelties that may weigh 100 pounds are **Mammoth, Mammoth Chili, Mammoth Whale,** and **Etampes.**

B.—Cucurbita Pepo, Pumpkin, Summer Squash, Vegetable Marrow. Mostly early maturing; leaves pointed, deeply indented between lobes, prickly, with partially naked basal veins; corolla lobes more pointed than in *C. maxima;* fruit stem 5 to 8 sided, grooved, hard; seeds comparatively small, usually tan coloured, with a horizontal or rounded scar, and with the margin of same colour and texture as body of the seed; summer squashes and marrows used while immature; plants ranging from the bush habit of the Scallop group to the coarse, vigorous, vining habit of the Pumpkin group.

1. *Field or Pie Pumpkin group.* Fruit orange coloured, grooved, oblong, or round and flattened at both ends. (a) Trailing habit—Connecticut Field, Dickinson, Small Sugar, Winter Luxury, Ft. Berthold, Golden Oblong, Omaha, Tours, Sandwich Islands, Early Cheyenne Pie; (b) Bush habit—Cheyenne Bush (very small).
2. *Vegetable Marrow group.* Fruit long, tapering from blossom to stem end, white, yellow, green, or striped, with smooth skin; both bush and vining varieties.
   - (a) English vegetable marrow; more popular in England and Canada than in the United States.
     - (i) Bush type: White Bush, Green Bush.
     - (ii) Vining type: Long Green, Long White, Cream.
   - (b) Italian vegetable marrow: Cocozelle, Zucchini.
   - (c) Vegetable spaghetti (Manchurian squash).
3. *Summer Crookneck group.* Bush habit; fruit yellow or white; warty; commonly with long, curved neck but certain strains have straight necks; Summer Crookneck, White Summer Crookneck, Early Prolific Straightneck, Yankee Hybrid.
4. *Scallop or Patty Pan group.* Fruit flat, edge scalloped (resembling a kitchen pan). Bush habit: White Bush Scallop, Green Tinted Bush Scallop, Yellow Bush Scallop.
5. *Fordhook group.* Fruit short club shaped and longitudinally grooved; both bush and vining varieties: Fordhook Bush, Fordhook Vine, Delicata, Table Queen (Acorn, Des Moines), Golden Table Queen, Mammoth Table Queen.

Connecticut Field is much used for canning and to some extent for pies and is comparativey large. **Dickinson** is especially valued by commercial canneries. It is a late variety that is well suited to western Ontario. It is reported that it does not need to be peeled or require the addition of sugar, starch, or colouring, as the flesh is orange, sweet, and of high quality. **Small Sugar** is the noted New England pie pumpkin

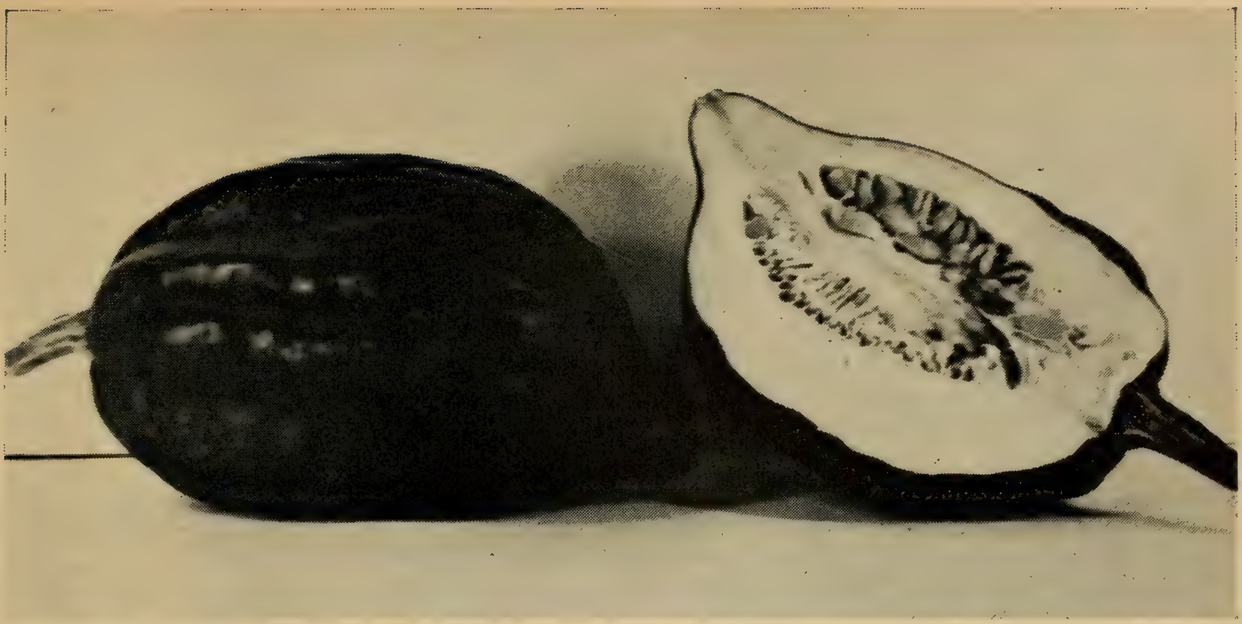


Fig. 40. Table Queen (Des Moines, "acorn", or "pepper") squash.

used during fall and at Thanksgiving. It is smaller and of better quality than Connecticut Field. **Early Cheyenne Pie** is an inbred strain of Small Sugar. It was bred to tolerate cool conditions and is a good variety for the northern section of eastern and central Ontario. The quality is excellent for pies or baking.

The name English vegetable marrow really refers to a type or group rather than to a variety. When a person buys seed of this so-called variety, he may get different varieties according to the source of seed. Three bush varieties are **White Bush Marrow, Custard** (greenish-white), and **Green Bush Marrow.** Two leading vining varieties are **Long White** and **Long Green.**

With Italian vegetable marrow, as with English vegetable marrow, the name refers to a type. Two leading varieties are **Cocozelle** (light green stripes) and **Zucchini** (dark green), and there are several strains of each. **Cozini** (Black Zucchini x Long Black Cocozelle) is characterized by dark-green fruits.

Vegetable Spaghetti is a novelty. If the yellowish-orange mature fruit is cooked whole for about 20 minutes and then cut open, the flesh is in loose shreds, somewhat resembing spaghetti in appearance.

In **Summer Crookneck,** the light yellow fruit is decidedly curved, crooked-necked to about half the length, and with an enlarged portion in which the seeds are contained at one end. **Early Prolific Straightneck** is more easily packed for shipment, and is popular with those who transplant summer squash from pots or bands. **Yankee Hybrid** is a leading white-skinned summer squash with light green flesh. It is a first-generation hybrid and combines earliness with productivity. The fruits are straight with thick necks and fit well into containers. It, too, is useful for transplanting.

The fruits of **Table Queen** (pepper squash) are dark green, small (5 to 6 x 4½ inches), acorn-shaped, smooth, and thin shelled, mature between summer and winter sorts, are a nice size to cut in half and bake, and are of high quality. **Golden Queen** is slightly larger and deep golden in colour.

C.—Cucurbita moshata, commonly called pumpkin or squash but referring to a different species than that usually grown in northern areas. Vines soft hairy (at tips at least), vining; leaves, though similar to those of *C. Pepo,* not deeply indented, but often acutely angled, usually with white spots; the basal veins covered by the decurrent blade; corolla lobes pointed; attachment to the fruit flaring if the fruit stem is distinctly 5 sided and grooved; attachment hard and not noticeably enlarged if the fruit stem is roughly cylindrical; fruit stalks corky in appearance but not in feeling; seeds grayish white to tan, scar slanting, horizontal, or rounded, and the distinct wavy margin deeper in colour and of a different texture than the body of the seed; seeds in the Cushaw type large and enameled with irregular engraved markings; with some exceptions, lacking in flavour, and hence largely used for stock feed in the regions with a long season.

Calhoun, Canada Crookneck, Cheese (deep salmon-orange flesh), Golden Cushaw, Green Striped Cushaw, Japanese Pie, Kentucky Field, Tennessee Sweet Potato, Yokohama, Virginia Mammoth, Quaker Pie, (pear-shaped fruit), Butternut, Turkish Honey.

From time to time Canadian seedsmen have tried to increase interest in the club-shaped members of this species. The seed of this group is contained in a small cavity at the far end of the club. This means that the main part of the club is a bar of solid flesh. In the **Butternut** variety the solid bar is close to 12 inches long. With **Turkish Honey** during extra warm seasons the solid bar may extend to a length of 2 feet.

RADISH

Radish seed should be sown about ¼ inch deep. Deeper seeding often leads to off-type roots and to a high percentage of plants that form useless roots. In the same variety, seed sown shallow produces roots that are comparatively round, whereas those resulting from deep seeding tend to be more elongated than is normal.

A.—Early or spring type. Comparatively mild, quick-maturing, reaching edible maturity in 24 to 30 days.

1. Round-, globe-, or turnip-shaped.
   (a) Entirely red: Scarlet Globe, Saxa, Early Scarlet Turnip, Cavalier, Comet, Cherry-Belle.
   (b) Red top, white base: Sparkler, Scarlet Turnip White Tip.
   (c) Entirely white or yellow: Box, Golden Globe, White Turnip.
2. Half-long-, olive-, or oval-shaped.
   (a) Entirely red: Early Deep Scarlet Olive, Half Long Scarlet.
   (b) Red top, white base: French Breakfast.
   (c) Entirely white: White Rocket.
3. Long.
   (a) Entirely red: Long Scarlet.
   (b) Red top, white base: Long Scarlet White Tip, Cincinnati Market, Wood's Frame.
   (c) White: Icicle, White Vienna, Pearl.

B.—Summer type. Larger and a better keeper than type A; mature in 30 to 48 days.

1. Round-, globe-, or turnip-shaped. White or yellow: Yellow Ball.
2. Half-long-, olive-, or oval-shaped. White: White Delicious.
3. Long.
   (a) Red top, white base: Chartier.
   (b) White : Long White Summer, Giant White Summer.

C.—Winter type. Quite pungent, large; mature in 50 to 60 days, or more; planted so as to reach a desirable size in autumn, when they may be stored and will keep for several months under good conditions.

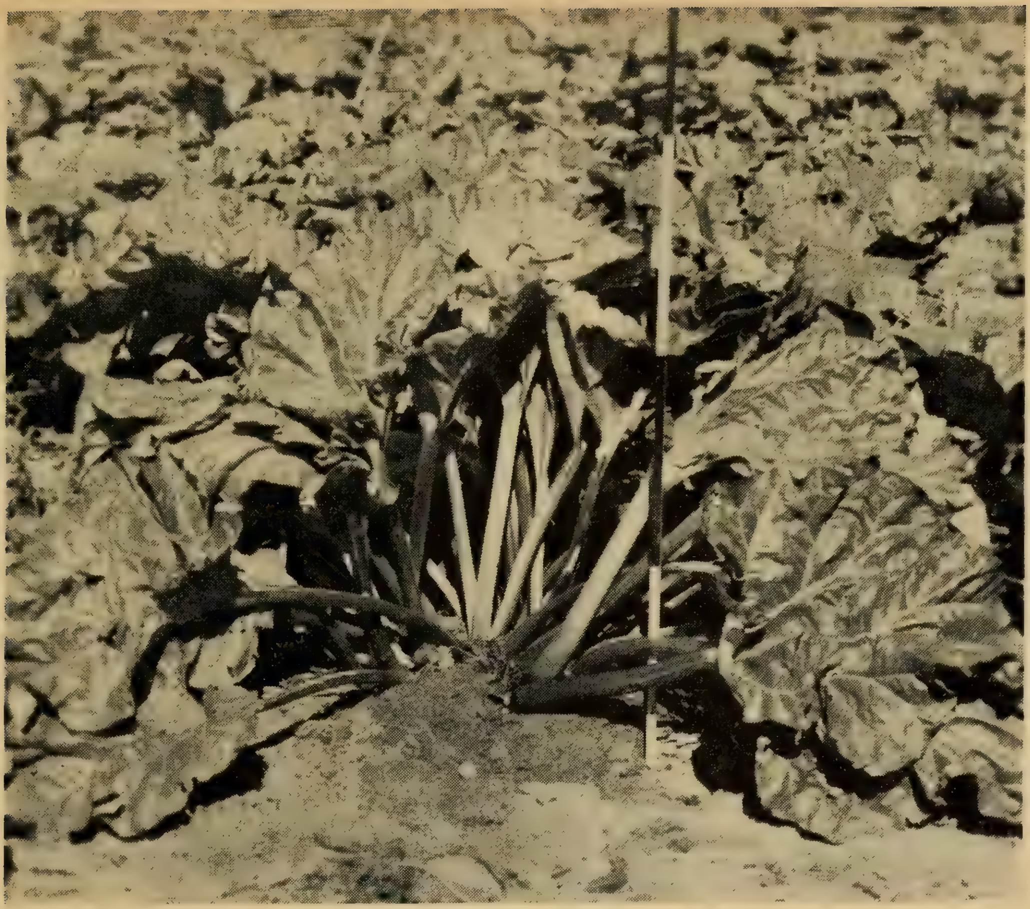


Fig. 41. Valentine rhubarb.

1. Round-, globe-, or turnip-shaped.
   - (a) White: Sakurajama.
   - (b) Black: Round Black Spanish.
2. Half-long-, olive-, or oval-shaped. Black: Half-long Black Spanish.
3. Long.
   - (a) Red: China Rose.
   - (b) White: China White, Nerima, California Mammoth White.
   - (c) Black: Long Black Spanish.

In general, red varieties are preferred. White radishes usually remain in good condition somewhat longer. It is difficult to make selections based on evidence of decided superiority without knowledge of where the seed has been produced, the conditions and care under which it is to be grown, and a number of other factors. The leaders in the early or spring type are **Scarlet Globe** (Cavalier, Comet), **French Breakfast, Scarlet Turnip White Tip** (Sparkler), and **Icicle.**

RHUBARB

Rhubarb is one of the few vegetables that is not propagated by means of seed.

Valentine, which originated at the Horticultural Station, Vineland, and **Macdonald,** which originated at Macdonald College, P.Q., are outstanding. **Ruby,** from the Central Experimental Farm, Ottawa, and **Sunrise** from the Experimental Station, Kentville, N.S., are two other good Canadian originations. The name "Strawberry" really refers to a type (colour) rather than to a distinct variety.

RUTABAGE, *see* TURNIP

SALSIFY

Salsify is grown for its edible roots. There are these three types:

A. White Salsify ("Vegetable Oyster"). The roots are long and slender with white skin and flesh. **Sandwich Island** is the chief variety.

B. Black Salsify or *Scorzonera.* The roots are long, slender, black outside, and white inside.

C. Scolymus or *Spanish Salsify.* The root is longer than that of White Salsify. The prickly leaves make it unpleasant to handle.

SPINACH

There are at least four distinct plant types or sex classes in spinach, based on the nature of the flowers that occur on the flowerstalks and certain other characteristics. The only sex which is mentioned here is known as the "extreme male", and in this case the plants bear flowers that are entirely male. Extreme male plants are small, unattractive, early bolting, and useless.

Prior to World War II, extreme males were not a serious factor as seed growers in Holland dominated the growing of spinach seed and they used methods that practically eliminated quick-bolting types. During World War II the growing of spinach seed for Ontario's requirements was transferred to Canada and the United States, and this resulted in a decided increase in the percentage of extreme males found within the various varieties.

It is difficult at the present time to describe a spinach variety, as, because of the presence of many extreme male plants, it is unlikely that the variety will live up to the description. Certain stocks have deteriorated so much that when they are grown on light soils only an expert can recognize the variety. The descriptions which follow are accurate when the seed has been carefully processed, and has also been sown in Ontario on rich, friable land.

In the key which follows, spinach varieties are separated into round-seeded and prickly-seeded types. Prickly-seeded varieties are only mentioned briefly, as they are not grown to any extent in Ontario.

A.—Round-seeded.

1. *Smooth-leaved* (or slightly savoyed in cool weather).
    (1) Early-bolting or not long-standing: Broad Flanders, Gaudry, Viroflay, Eskimo Giant.
    (2) Slow-bolting or long-standing: King of Denmark, Viking (Heavy Pack), Nobel (Giant Nobel, Giant Thick Leaved), Darkie, Giant Fillbasket, Northland.
2. *Savoy-leaved.*
    (1) Early-bolting or not long-standing.
        a. Mosaic- or blight-resistant: Virginia Savoy, Old Dominion.
        b. Not mosaic-resistant: Bloomsdale Savoy (Savoy Leaved or Bloomsdale), Dark Green Bloomsdale.
    (2) Slow-bolting or long-standing: Juliana, Long Standing Bloomsdale, Summer Savoy.

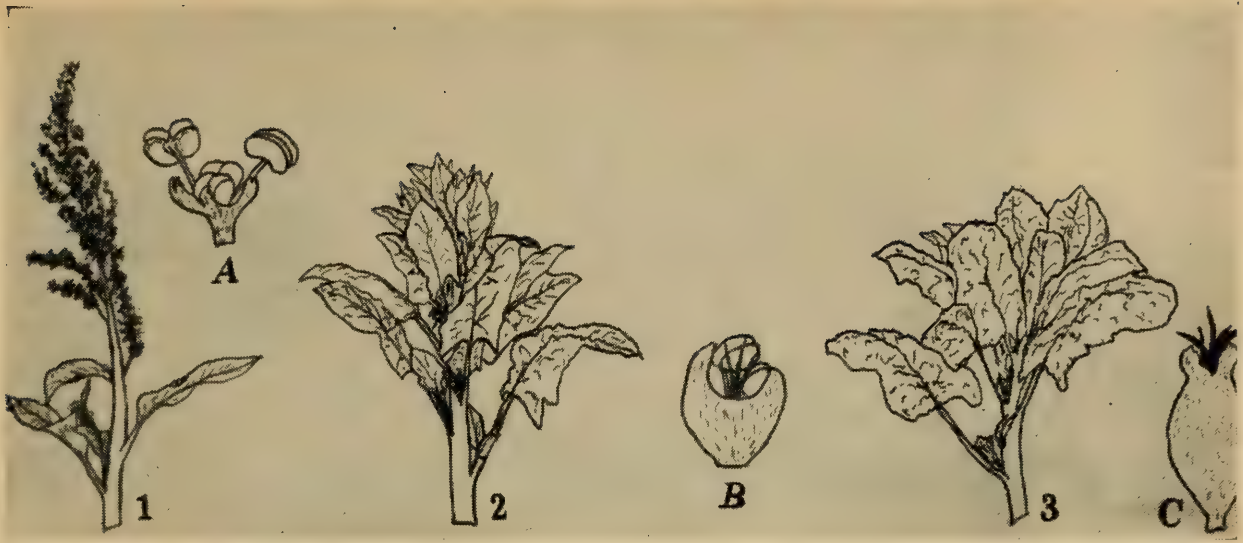


Fig. 42. *A.* Staminate, *B*, hermaphroditic, and C, pistillate flowers. 1: Extreme male plant bearing staminate flowers. 2: Vegetative male bearing staminate flowers. 3: Female plant bearing pistillate flowers. Monoecious and hermaphroditic plants may resemble 2 or 3 or any intermediate of these two, the monoecious having staminate and pistillate flowers, and hermaphroditic plants having flowers as in B. Still another type of plant, which resembles 2 or 3, may have staminate and hermaphroditic flowers, or there may be pistillate and hermaphroditic combinations.

B.—Prickly-seeded.
  1. *Smooth-leaved* (or slightly savoyed in cool weather).
    (1) Early-bolting or not long-standing.
      a. Mosaic-resistant: Japanese Prickly, Manchuria.
      b. Not mosaic-resistant: Prickly or Winter, Hollandia, Morse Dark Green Prickly Seeded.
    (2) Slow-bolting or long-standing: Amsterdam Giant.
  2. *Savoy-leaved.*
    (1) Early-bolting or not long-standing.
      a. Mosaic-resistant: Presto Blight Resistant.
      b. Not mosaic-resistant: Presto.

Bloomsdale Savoy is the leading market garden spinach for first sowing in early spring. It matures quickly. The leaves are dark-green, crumpled, and suitable for home and market gardeners, shippers, and canners. **Dark Green Bloomsdale** is similar but slightly later than Bloomsdale Savoy. The leaves are darker green and it holds a fresher appearing green colour while in transit to market. A decided improvement over Bloomsdale Savoy for late spring or fall crop is found in **Bloomsdale Longstanding,** which produces attractive, dark-green, heavily crumpled leaves. **Summer Savoy** is a longstanding type similar to Bloomsdale Longstanding from which it was selected.

Nobel is the outstanding variety among the "giant", thick-leaved types. It is early, of excellent quality, and adapted for use by gardeners and canners. The leaves are very large, broad, firm, tender, smooth, and bright green. **Gaudry, Giant Fillbasket,** and **Northland** are very similar.

Virginia Savoy is a quick-growing, blight-resistant variety with dark-green leaves which in the fall are crumpled. It has been popular for many years for summer sowing for fall harvest. It is considered to be one of the best varieties to sow around September 1 in southern Ontario for wintering over for an early spring crop, but it should be avoided for spring sowing. **Old Dominion** (Virginia Savoy x King of Denmark) is an improved strain of Virginia Savoy. It develops large, dark-green, crumpled leaves, and is adapted to sowing for fall spinach and to wintering over for an early spring crop. **Viking** is slightly darker, larger, more crumpled, and somewhat longer standing than Nobel; it resembles in many ways a short-petioled King of Denmark.

King of Denmark is about the slowest smooth-leaved variety to produce seedstalks; the blue-green foliage colour is duller than that of Nobel. **Darkie** resembles King of Denmark, but the petioles are shorter, and the blades darker green, smoother, and thicker. **Juliana** has blue-green leaves of high quality, the plants are small in size, slow growing, and can be spaced closer than other sorts.

SQUASH, *see* PUMPKIN

SWEETPOTATO

In attempts to grow the sweetpotato in Ontario it is not uncommon to plant a larger quantity of tubers than is harvested as the crop. In certain years success has been reported from some of the warmer districts.

There are two main groups: (a) (favoured in northern markets) dry and mealy, such as Big Stem Jersey and Yellow Jersey. (b) (favoured in southern markets) flesh soft, moist, and sugary when cooked, such as Nancy Hall and Porto Rico. These four varieties constitute about 90 percent of the commercial crop in the United States. Large sweetpotatoes and those with a moist, soft texture when cooked are called "yams."

TOMATO

It is possible to arrange tomato varieties and hybrids into quite a number of groups, and these are set forth. Information is presented, too, on the problem of disease resistance.

A. Indeterminate (standard). Plants capable of continuing their growth more or less indefinitely; normally, a blossom cluster is produced at every third internode, and so being separated by three leaves. Such a heavy number of leaves to each fruiting cluster gives this type a nutritional advantage and it includes the varieties most popular for their excellence of flavour and intensity of colour.

1. *Earliana group.* Immature fruits green streaked; mature fruit 4½ to 5½ ounces, deep oblate or flattened-globe shape with a slight tendency to be pointed, corky ring inconspicuous, stylar scar medium, cells 10 to 12, cell arrangement irregular; lacking in uniform ripening and colouring; circular cracks common, radial cracks rare; plant sprawling, comparatively small, foliage density open; season early; chief use: home and early market.

(a) Fruit red: Abel, Bestal, Burbank, Earliana, Harkness, Penn State Earliana Morse Earliana 498, Red River, Avon Early, Earliosa, First Early.

(b) Fruit pink: June Pink.

2. *Valiant or Second Early group.* Plants and fruits similar to Bonny Best group except that the vines are slightly smaller, not as heavy yielding, and the fruit matures slightly earlier. Although seldom used for canning the varieties find some favour for market garden purposes as they combine earliness with market type.

Fruit red: Nystate, Crackproof, Early Market, Scarlet Dawn, Redcap, Ventura, Valiant (Stokesdale No. 4).

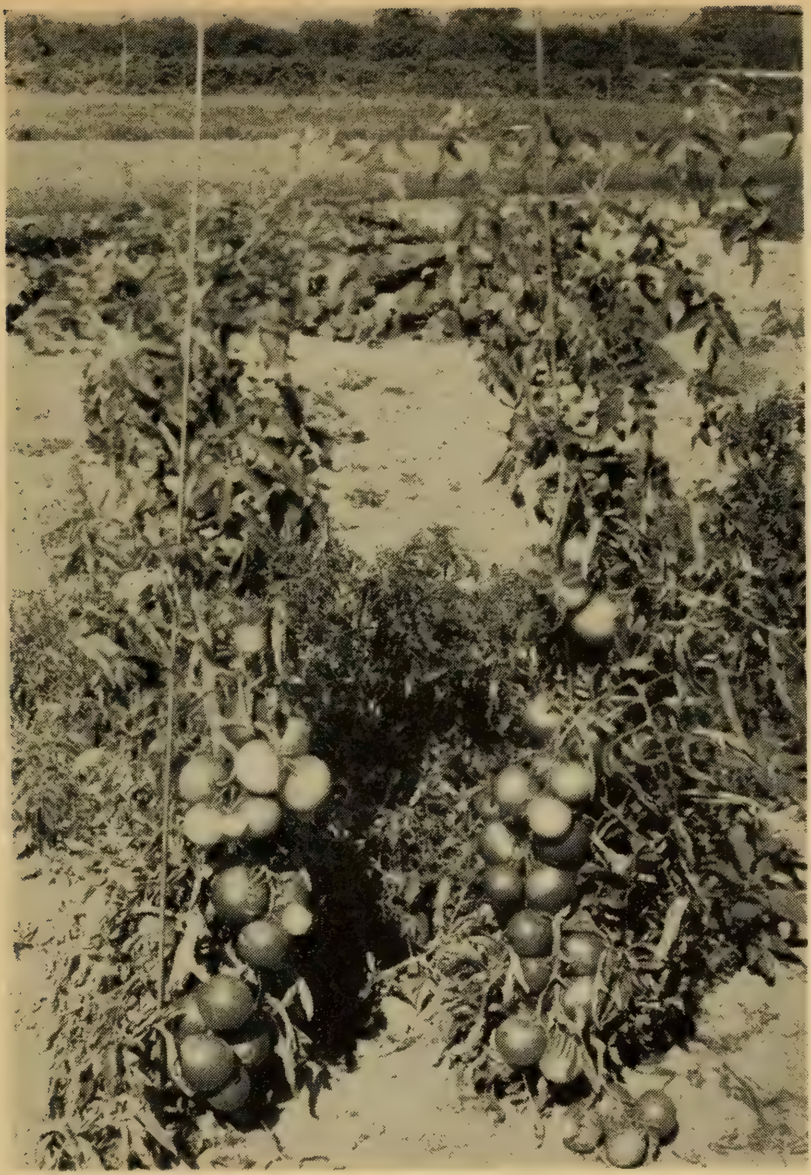


Fig. 43. Harkness tomato.

3. *Bonny Best group.* Fruit 4½ to 5½ ounces, deep oblate, corky ring conspicuous, stylar scar a mere dot, cells 6 to 7, cell arrangement regular; radial cracks common, circular cracks rare; plant semi-erect, spreading, medium size, foliage density slight; second early; chief use: home garden, market garden, and canning.

Fruit red: Bonney Best, Chalk Early Jewel, John Baer, Geneva John Baer, Clark Early, Stokesdale, Landreth, Early Canner, Cobourg (private stock of John Baer developed by the Canadian Canners at Wellington).

Within this group, **Stokesdale, Bonny Best, John Baer,** and **Chalk Early Jewel** are used extensively for canning, and the last-mentioned variety is also much used in the manufacture of catsup. **Geneva John Baer** is a strain of John Baer characterized by a somewhat better colour; it was developed by the Experiment Station, Geneva, N.Y.

4. *Globe group.* Fruit 6 to 7 ounces, globular, corky ring negligible, stylar scar small, cells 5 to 6, cell arrangement regular; plant semi-erect, spreading, large, foliage density medium; late; not grown extensively in Ontario, except in home gardens in the warmer sections.

Fruit pink: Globe (Livingstone Globe), Gulf State Market, Early Detroit.

5. *Marglobe group.* Fruit 6 to 7 ounces, globular, corky ring conspicuous, stylar scar small, cells 6 to 7, cell arrangement regular, plant semi-erect, foliage dense; late; chief use market and canning.

(a) Fruit red: Master Marglobe, Marglobe, Early Rutgers, Rutgers, Break o' Day, Grothen Red Globe, Longred (Geneva No. 5).
(b) Fruit pink: Globel, Marhio, Judy Pink.

In this group, **Rutgers** is especially favoured in western Ontario for canning.

6. *Stone group.* Fruit 6 to 7½ ounces, flattened to deep flattened, corky ring conspicuous, stylar scar medium to large, cells 7 to 9, cell arrangement irregular; plant semi-erect, medium large to very large, foliage dense; late midseason to late; chief use: canning.

(a) Fruit red: Stone, Early Baltimore, Greater Baltimore, Indiana Baltimore, Norton, Santa Clara Canner, Garden State (Scarlet Canner).
(b) Fruit pink: Pepper.

In this group, **Early Baltimore** and **Garden State** are much used for canning in southwestern Ontario.

7. *Ponderosa group.* Fruit 9 to 16 ounces, (i) rather flat but fairly deep and often oval in transverse section or (ii) heart-shaped, rough, scar broad, cells numerous irregular, and well filled with pulp but with few seeds; flavour notably mild; plants very large, open, and spreading; late to very late; chief use: for slicing raw.

(a) Fruit red: Beefsteak.
(b) Fruit pink: Ponderosa, Oxheart, Brimmer.
(c) Fruit yellow: Golden Ponderosa.
(d) Fruit white: Snowball.

8. *Best of All or Comet group.* Fruit rather small, flattened, smooth, few-celled, firm, well-coloured, uniform; adapted for greenhouse and for trellis culture outdoors, and at times such varieties as Signet are used for home canning, as the members of this group are often higher than average in Vitamin C. Within this group belong many of the varieties which are grown by Ontario market gardeners, the seed being purchased through Ontario dealers handling British seed. Tomato varieties from Great Britain are much more popular with the buying public than one might normally expect, considering that from a Canadian standpoint the fruit is small in size.

These varieties are popular because they are the ideal size to pack in a lunch box, and for munching between meals. On the other hand, they are likely to be few-celled, many-seeded, and lacking in meatiness. They are early, prolific, and readily adapted to staking, and are seldom grown as ground tomatoes. The small fruits sell well in 6-quart and 11-quart containers on the Hamilton, Toronto, and Montreal markets, and are shipped as far west as Winnipeg.

Fruit red: Best of All, Earliest of All, Sunrise, Comet (Minute Man), Grand Rapids Forcing, Signet.

9. *Potato-leaved group.* This type is characterized by strong vines and large, heavy, entire-margined leaves which resemble those of the potato. In the past there have been on the market several potato-leaved types, ranging from a potato-leaved Earliana, known as Way-A-Head, to

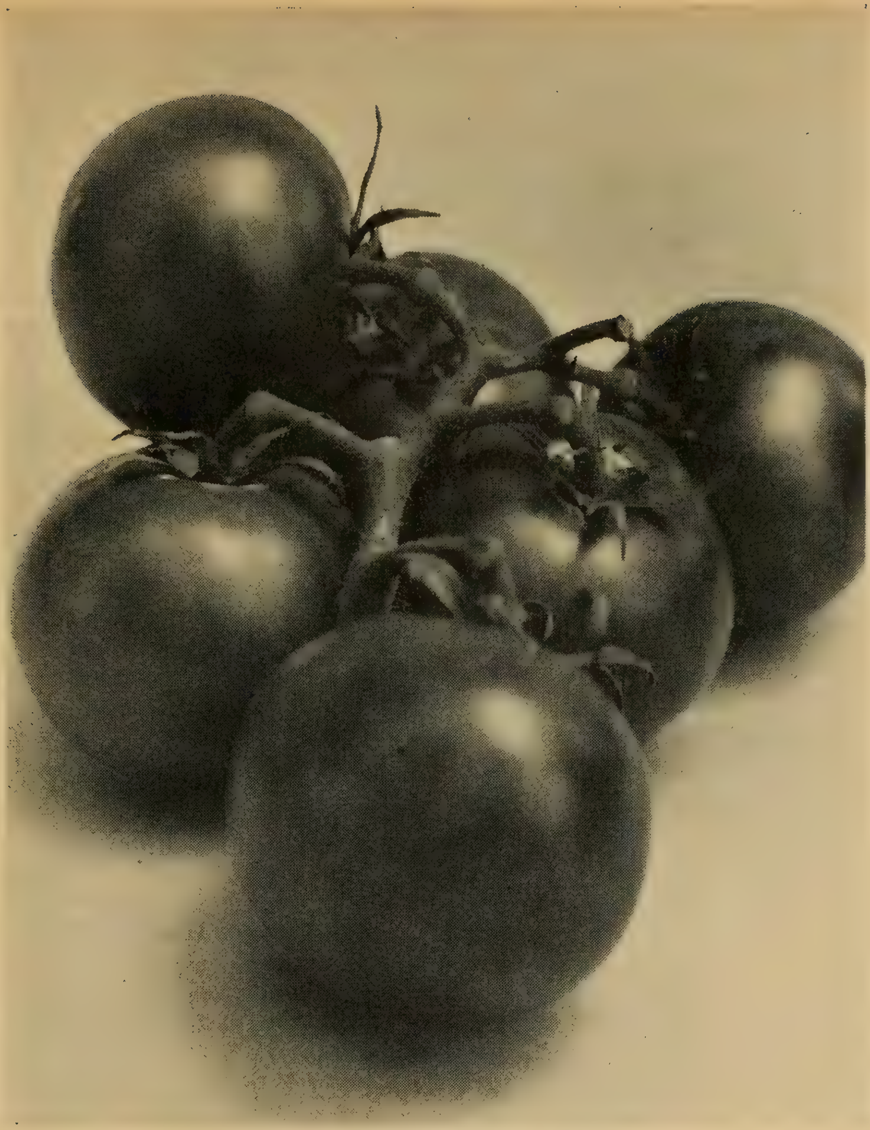


Fig. 44. Fordhook Hybrid tomato.

the very late, robust Giant Tree or Italian Potato Leaved variety. No potato-leaved variety is of economic importance in Ontario at the present time. Red Jacket (Geneva No. 3), because of its heavy foliage cover, may prove to have some value in districts where the fruit needs protection from hot, dry winds and bright sunlight. It is midseason in maturity with large, flattened, red fruit.

Fruit red: Way-A-Head, Italian Potato Leaf, Red Jacket (Geneva No. 3.)

10. *Stemless group.* The fruit lacks an abscission layer and when it is picked the stem and calyx remain on the plant instead of parting from the vine and being attached to the fruit as in most varieties. The stemless factor may eventually have value as canning companies do not look with favour on the presence of stems on the fruit. Also, no stem remains on the fruit to puncture other fruits in the basket when packed. The plants are spreading with slightly "wilty" foliage, but this latter characteristic does not affect the vigour. Instead of bearing fruit clusters that consist of several fruits as is normally the case in tomatoes, stemless varieties bear fruits at short intervals on secondary branches. This results in the development of fruits of more uniform size than when produced

in the normal type of cluster. There is no need to prune or stake stemless types. The first two stemless types were introduced in 1944.

(a) Fruit red: Pennred.
(b) Fruit orange: Pennorange.

11. *Hybrid group.* As in the production of hybrid sweet corn, hybrid tomatoes are produced by the crossing each season of two inbred lines. The crossing of two lines with high combining ability causes hybrid vigour which is manifested by increased yields, and at times very heavy yields even in the first pickings. At present the cost of producing hybrid tomato seed is high because the hybridization is done by hand. A new breeding technique is being worked out that will eventually reduce the cost of hybrid seed to a point where large scale growers and canning companies can make bulk purchases. It seems probable that the use of hybrid tomato seed will soon expand. A warning is necessary where hybrid types are concerned. A hybrid may only do well in a localized area. Its extra vigour can be reduced by subjecting it to climatic and soil conditions to which it is not suited.

Certain of the best hybrids introduced to date are as follows:

Fordhook Hybrid. Under Ontario conditions it is similar in season to Bonny Best. Fruit is small to medium in size, flattened to round in form, smooth, well coloured, attractive, and of value for home and market garden. In suitable locations it outyields non-hybrid types.

Burpee Hybrid. Late type, being slightly earlier than Marglobe. Heavy yielding with heavy vine growth, and medium sized well coloured fruits that are deep-flattened to round in form.

Clinton Hybrid. Slightly later than Burpee Hybrid and in season with Marglobe. Heavy yielding, with uniform, large sized fruits that are deep-flattened to round in form and of excellent quality. Clinton Hybrid will usually outyield either Fordhook or Burpee Hybrid, sometimes by as much as 25 percent.

Minnesota Hybrid "E" or **Faribault Hybrid** (Pritchard x Earliana, or Red River x Earliana). In this hybrid either Pritchard or Red River are used interchangeably, but Pritchard is preferred. Almost as early as Earliana it is a higher yielder and superior in quality. As far as is known this hybrid is not exceeded in the production of early marketable fruits by any other variety, hybrid or otherwise.

Cornell Hybrid. (Earliana x Valiant). Resembles Earliana, but is earlier, heavier yielding, and slightly superior in quality. It is a valuable early staking sort for market gardeners. Cornell University has developed another hybrid (Earliana x Rutgers) which is slightly later in maturity and with superior fruit. So far, however, seed of this latter hybrid has not been sold commercially.

Spartan Hybrid. (Michigan State Forcing x Cooper Special). Greenhouse hybrid. Stated to be a week earlier than the parents and approximately 20 percent more productive. The scarlet fruits average three per pound.

Northern Hybrid. (Michigan State Forcing x Sutton Best of All). Greenhouse hybrid. Stated to grow indoors with vigour under winter

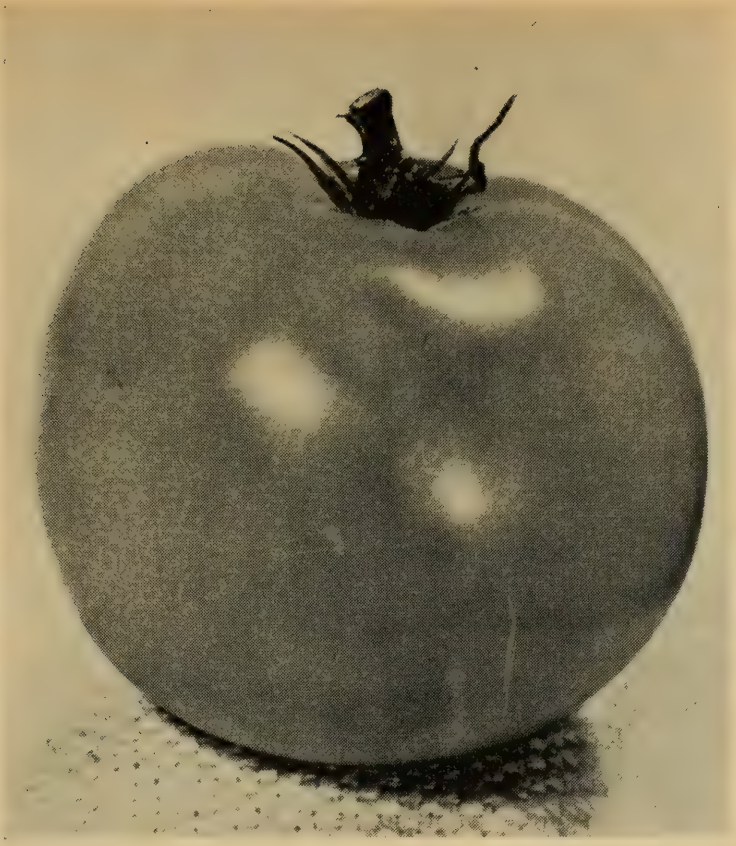


Fig. 45. Burpee Hybrid tomato.

conditions and for this reason to have special value in Ontario. Fruit red, globular, but smaller than Spartan Hybrid.

12. *Golden Queen group.* Fruit glossy medium green when young, becoming bright golden yellow when ripe, sometimes faintly blushed with red, size varies from medium to large. Time of maturity is medium to late.

Fruit yellow: Golden Queen, Golden Dawn, Golden Globe.

13. *Tangerine or Jubilee group.* A number of tangerine-coloured tomatoes have been introduced lately both as determinate and indeterminate types. The old-fashioned, large-fruited Tangerine variety is now off the market and has been superseded by Jubilee, which is an attractive large-fruited type. This variety has an orange exterior colour with tangerine-orange-coloured flesh. This type may gain in importance as it has "eye appeal" and the juice also is attractive and high in vitamin values.

Fruit orange: Tangerine, Jubilee.

14. *White Apple group.* Fruit small and late. Fruit colour is not attractive as it varies from a pale waxy yellow to a faded yellow over blossom end to light yellow at stem end. Flavour is mild, and to some is insipid. White tomatoes are often catalogued as being so low in acidity that they can be used by those who avoid acid fruits.

Fruit white: White Apple, White Queen, White Beauty.

15. *Interspecific group.* Several tomato species that grow wild in Peru and surrounding districts are resistant to certain parasitic diseases of the cultivated tomato *(Lycopersicon esculentum)* in Canada, the United States, and Hawaii. Among these wild species are the following: *L. chilense*, *L. hirsutum*, *L. peruvianum*, and *L. pimpinellifolium*.

The species *L. chilense and L. hirsutum,* through crossing with commercial varieties, are being used to develop new varieties which will escape either tobacco mosaic or leaf mold.

Strains of *L. peruvianum* have been found which are highly resistant to the root knot nematode. When the pollen of *L. peruvianum* is applied to the stigma of the flowers of the common tomato, *L. esculentum,* it causes fruit to set readily, but the seeds of these fruits fail to germinate. However, interspecific hybrids have been grown by culturing the embryos and nematode-resistant varieties likely will be introduced in a few years.

Strains of *L. pimpinellifolium,* the Red Currant tomato, have been located which are resistant to one or more of the following diseases: bacterial canker, spotted wilt, fusarium wilt, gray leaf spot, and leaf mold. *L. pimpinellifolium* crosses readily with plants of the common tomato and varieties resistant to these diseases are being developed.

At the present time F_1 hybrids in which the two parents are each resistant to one or more different diseases are being experimentally produced. These hybrids will combine resistance to more than one disease as well as heavy yielding ability.

Several disease-resistant varieties are being grown in Ontario. **Pan America** (Marglobe x *L. pimpinellifolium*) possesses the greatest resistance to fusarium wilt. It is similar to Marglobe, except that the plant and leaves are larger and more vigorous. It is a late variety and as such is generally recommended for the southern States. However, it can be grown successfully in southwestern Ontario on warm sites troubled with fusarium wilt.

Practically all greenhouse tomatoes grown in Ontario are types which are resistant to certain of the eight known races of leaf mold. Climatic and cultural conditions are favourable for this disease in Ontario greenhouses and the use of resistant varieties eliminates considerable risk.

Vetomold (*L. pimpinellifolium* x Potentate) originated at the Horticultural Experiment Station, Vineland Station, Ontario, as the outcome of a cooperative project with the University of Toronto. It is a greenhouse tomato immune to four races of leaf mold. Vetomold is preferred to other resistant varieties in houses that races 5 to 8 have not yet invaded.

V121 (*L. pimpinellifolium* x Potentate) is a sister selection of Vetomold which, although not immune to any races of mold, is highly resistant to six races. It is completely susceptible to two races, one of which has a wide distribution in Ontario. V121 is later than Vetomold. The blossom clusters are more branched and lack the regular formation found in that variety. The fruit is medium large averaging six or seven per pound with a greater range in size than Vetomold.

V473 (Vetomold x Stirling Castle) is the most recent greenhouse tomato introduced by the Horticultural Experiment Station, Vineland. It possesses the combined resistance of its parents. Thus far it has proved resistant in commercial houses. However, if either of the two races to which it is susceptible come to predominate, V473 will be attacked by leaf mold as readily as other varieties. The fruit is much deeper than Vetomold and therefore easier packed. Where leaf mold is not a factor it is smaller and less productive than Vetomold. The trusses are unbranched with a short shank and bear six or seven uniformly sized fruits.

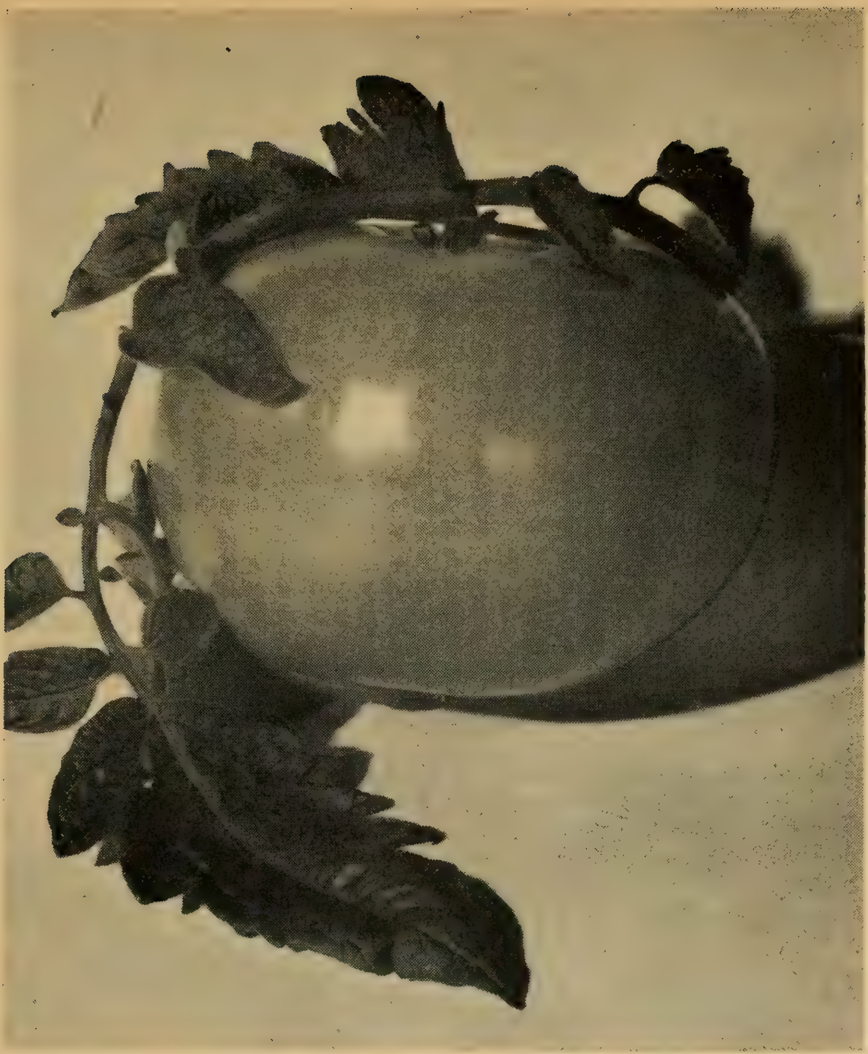


Fig. 46. Clinton Hybrid tomato.

16. *San Marzano group.* Fruit oblong, 3 inches long, 1¼ to 1½ ounces. Like other Italian varieties the flavour is mild, almost tasteless. Thousands of acres are grown in California of which about half is used for making paste and about half for canning whole as salad tomatoes.

Fruit red: San Marzano, King Humbert, Jan Ru, Italian Red Plum or Canner.

17. *Small-fruited group.* Mostly 2-celled.

(a) Currant type: Fruit red, somewhat larger than a large currant, borne in numerous, long, 2-ranked clusters; skin tough, not inclined to crack; about 350 fruits per pound.

(b) Peach type: Red, pink, and yellow forms; fruits globular, 1¾ inches, weight about 2 ounces; skin covered with fine hair, soft in texture, suggestive of a peach; cells with thin partition walls, puffy, and only partially filled with pulp and seeds; late.

(c) Cherry type: Red and yellow forms; fruit small (⅞ inch diameter and weight about 1/3 ounce), globular; midseason. Sometimes called "Sugar".

(d) Pear ("Fig") type: Fruit pear-shaped (2 x 1 inches and weight about ⅝ ounce), walls fairly thick; midseason.

(e) Plum type: Red and yellow forms. Fruit narrow egg-shaped, borne on long fruiting stems that are sometimes forked 7 to 9 fruits in a cluster, 2 inches long, 1½ inches thick, and weight about 1 ounce, thick outer and inner walls; midseason.

B.—Indeterminate (dwarf or tree). Fruit 4 ounces, flattened-globe shape, broad shallow cavity, scarred at blossom end; plant upright with short, thick, stiff stems, internodes much shorter than in standard varieties, plants never spreading, commonly about 2 feet tall and dwarfed-tree-like in appearance; leaves thick, much curled, dark green; normally three leaves between each flowering truss; late; yielding less than standard varieties.

(a) Fruit red: Dwarf Stone.
(b) Fruit pink: Dwarf Champion.

C.—Determinate or Self-topping (bush). Very free blooming. Usually less than three leaves occur between the flowering trusses. Generally there are two leaves, sometimes one, and occasionally no leaves at all between one flower truss and the next. The stem eventually terminates in a blossom cluster; thus giving the so-called "self-topping" or "self-pruning" habit of growth. Further growth may take place from the axils of the leaves but the plants usually remain small. They are planted closer together than the indeterminate varieties. Determinate varieties have been found especially well adapted to sites which sometimes suffer from drought. They are not grown on stakes.

(a) Fruit red:
  (i) Earliest: Farthest North, Window Box, Tiny Tim.
  (ii) Very early: Redskin, Polar Circle, New Alaska.
  (iii) Early: Early Chatham, Sioux, Viking, Bison, Bounty, Victor, Firesteel, Red Cloud, Gem (Geneva No. 2), Stonor Dwarf Gem, Pennheart, Danmark, Morskin.
  (iv) Midseason: Pearl Harbor, Pritchard (Scarlet Topper).
  (v) Late: Pearson.
(b) Fruit pink: Cooper Special, Fargo (Rosebush).
(c) Fruit yellow: Golden Bison, Morden, Mingold.

D.—Determinate or Self-topping (dwarf). This type has been developed by crossing bush and dwarf forms. The fruit varies in size according to the variety. Plant upright (about 15 inches); stems stout, without side shoots; leaves thick in texture, dark green. This low-growing, sturdy group excels all others for windy, dry situations. It has been reported from Great Britain that this type is useful for comparatively cold, wet conditions. Work in Connecticut indicates a possible value for this type, because of the thick stems, as a parent in breeding varieties for outdoor sowing.

(a) Fruit red: NDAC 303.
(b) Fruit yellow: Plains Tree.

Leading Tomato Varieties

Market gardeners frequently grow British varieties for the early market. Those grown in Ontario are **Best of All, Earliest of All,** and **Sunrise.** These are almost always staked, and are topped at the third or fourth truss.

Bounty is the earliest, widely grown variety. As it is a determinate type with good-sized fruits it produces a large early yield per acre. It is popular particularly in areas of short season and in areas like the Niagara Peninsula where the early portion of the crop is marketed through the basket trade. It is being processed but on account of its pale colour gives

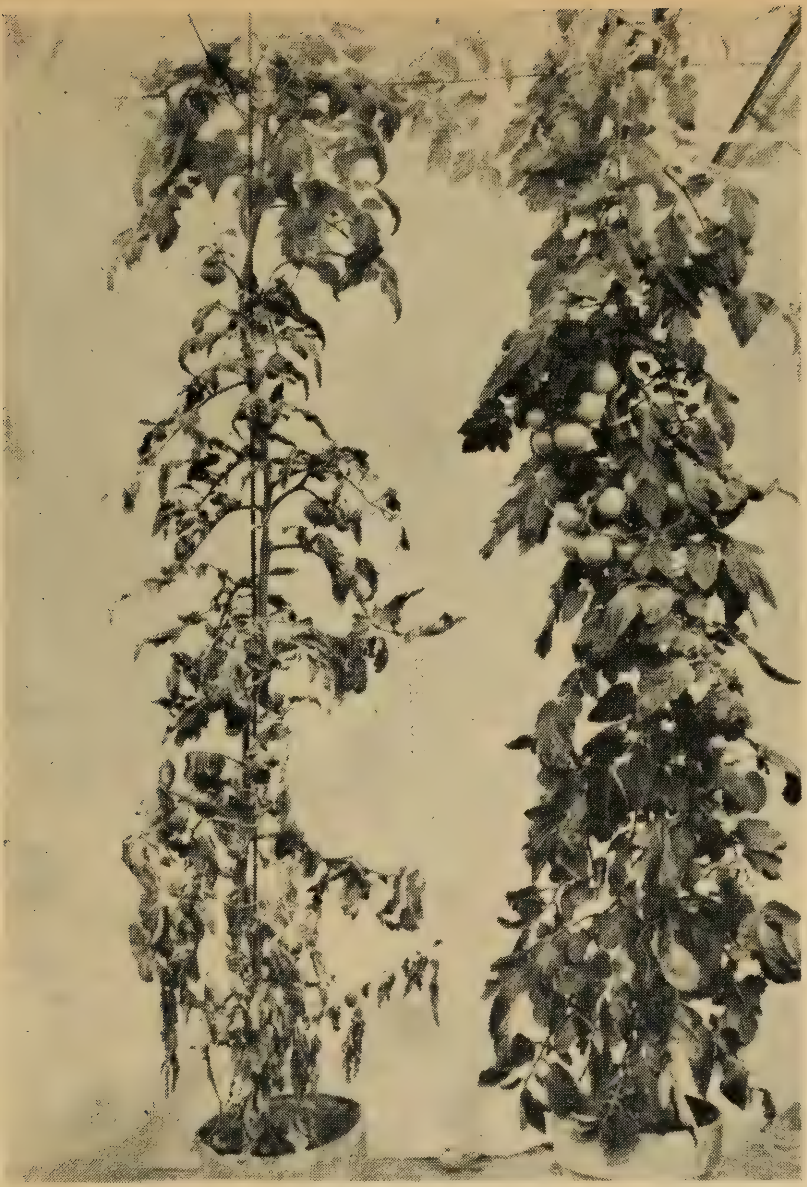


Fig. 47. *Left:* **Grand Rapids tomato plant destroyed by leafmold.** *Right:* **Vetomold plant showing resistance.**

a low-quality pack. **Earliana,** an indeterminate type is later, larger, and rougher, although in **Harkness** a smoother stock occurs. Harkness may be used for canning although it has not found favour with canning companies. It is valuable to the market gardener who is growing staked tomatoes for early market. It is also possibly the most resistant to cracking of all varieties grown in Ontario.

For home and market garden the two leading varieties are **Bonny Best** (John Baer) and **Stokesdale.** These are second early in maturity. Stokesdale is a trifle later than Bonny Best, makes a larger vine, and under favourable conditions produces an excellent yield of high-quality, globe-shaped, medium-sized fruit. It is a good canning variety where the season is somewhat shorter than Rutgers requires. It is definitely on the increase.

One of the leading varieties for canning in southwestern Ontario is **Rutgers.** Both it and **Garden State** ripen evenly from the inside out. Rutgers is resistant to fusarium wilt. It is doubtful if either Rutgers or

Garden State are as valuable in southwestern Ontario as the earlier canning type, **Early Baltimore.** This variety was developed at the University of Illinois as a selection from Greater Baltimore. The fruit is especially smooth and rich red in colour. The vine is resistant to fusarium wilt, and provides as good leaf coverage as in most of the present varieties.

In eastern Ontario, where conditions are cooler, the following varieties will likely give best success for canning: **Chalk Early Jewel, Bonny Best, Geneva John Baer,** and **Valiant** (Stokesdale No. 4).

Advance notice indicates that **Gem** (Geneva No. 2), which was introduced in 1947, is a heavy yielding type for canning and market, and is similar to Bounty in season.

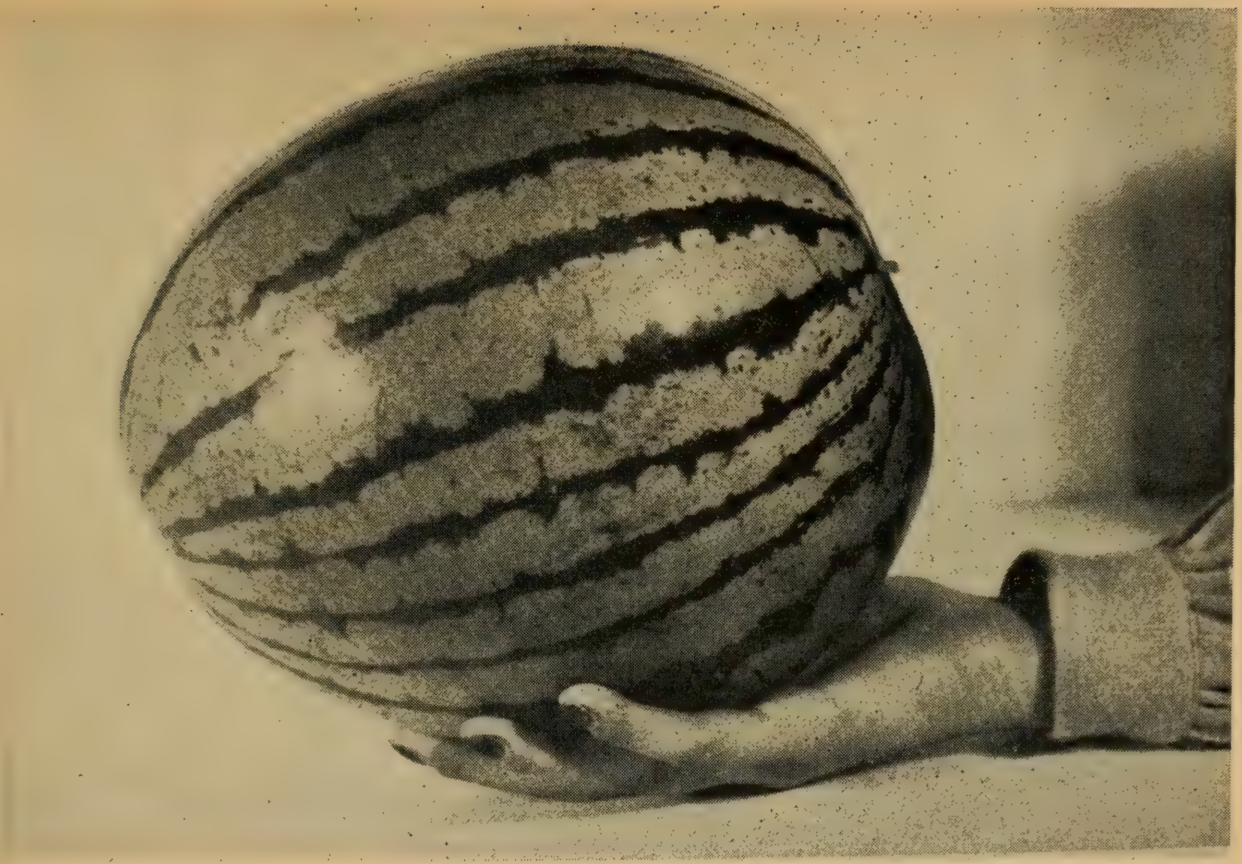
Northern Ontario requires very early varieties as the growing season is very short and sometimes July is the only frost-free month. **Abel,** the earliest of the indeterminate varieties, is one of the best staking sorts for short-season districts. **Farthest North** is the earliest variety of all. It is a self-topping variety and the fruit is very small. Other early determinate types are **New Alaska, Redskin, Early Chatham, Bounty,** and **Victor.** Seed of these varieties may provide a crop when sown outdoors in warm home-garden sites in the warmer districts of Ontario. This is not commercially practicable. **Window Box** and **Tiny Tim** are not quite as early as Farthest North. Window Box is adapted to outdoor sowing, the plants being thinned to 1 foot apart in rows 3 feet apart. Tiny Tim is primarily for ornamental use rather than for its edible fruit.

TURNIP

The turnip or soft turnip is an entirely different crop from the Swede turnip or rutabaga. The differences, as well as groups of varieties of each crop, are given in the classification which follows:

A. Turnip or soft turnip. Root often disc-like or decidedly flattened, though ranging from spherical to elongated conical; little or no neck; a distinct taproot, and secondary roots arising only from it; leaves and petioles hairy, coarse to the touch, yellowish green, slightly lighter below, smaller growth habit, open centred; edible maturity reached in 42 to 80 days.

1. White-fleshed.
    - (a) Purple-topped.
        - (i) Flat type: Purple Top Strap Leaf, Purple Top Milan.
        - (ii) Globe type: Purple Top White Globe.
    - (b) Bronze- or green-topped.
        - (i) Globe type: Green Top White, Green Globe, Green Stone.
        - (ii) Long type: Cowhorn.
    - (c) White-topped.
        - (i) Flat type: White Milan, White Flat Dutch, Norfolk.
        - (ii) Globe type: White Stone, Quicksilver, Ward Gem.
        - (iii) Half-long type: White Egg, White Gem.
        - (iv) Long type: Lily White.
2. Yellow-fleshed.
    - (a) Purple-topped, globe type: Aberdeen Purple Top.
    - (b) Bronze or green-topped, globe type: Aberdeen Green Top, Invincible, Amber Globe.
    - (c) Yellow-topped, globe to top-shaped type: Yellow Globe, Golden Ball, All Seasons.
3. Foliage varieties: Flat Japan, Shogoin, Broccoli-Raab, Tokio, Seven Top.



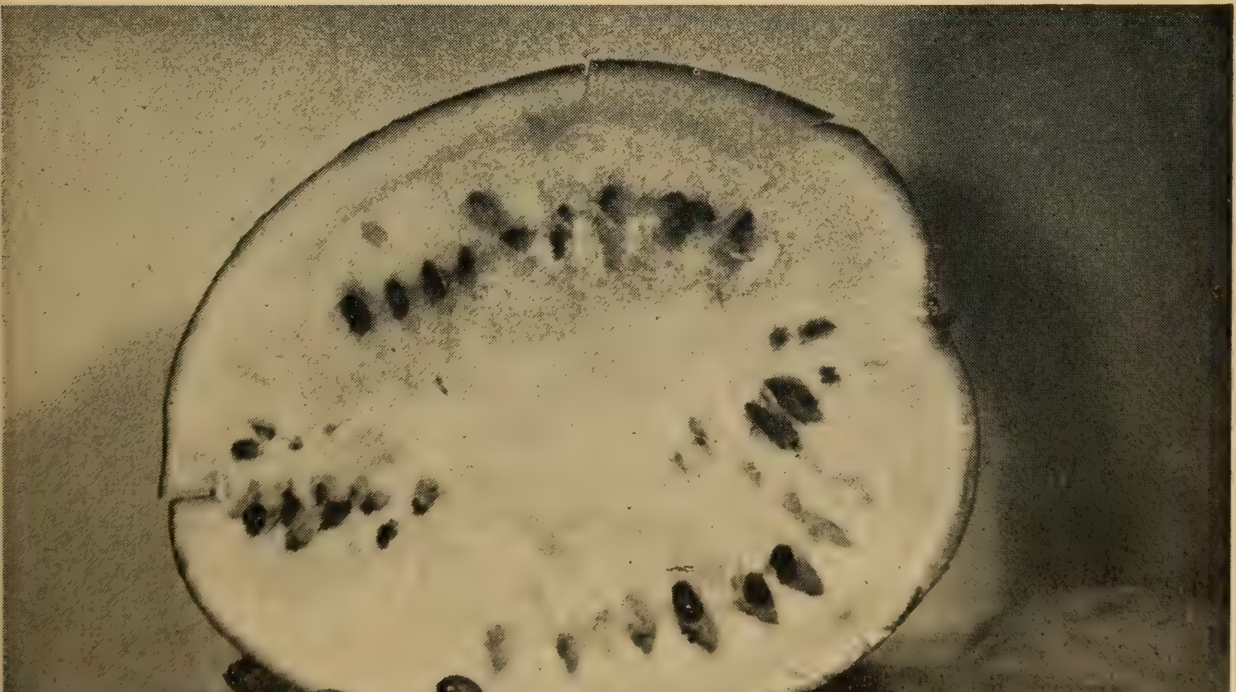


Fig. 48. Sweet Sensation watermelon.

Some leading turnip varieties are **Purple Top Strap Leaf, Purple Top Milan,** and **White Milan.** The foliage varieties of turnips are chiefly grown for "greens." **Seven Top** is much grown in regions with mild winters, for fall sowing and spring cutting but is of little value in Ontario. It is sometimes called Broccoli-Raab.

B. Rutabaga or swede turnip. Root deeper than turnip from crown to base; in general, ovoid shape though with modifications from flat to tankard; roots arising from the underside of the enlarged portion as well as from the fine taproot; rather prongy root condition; larger than most turnips; neck or crown prominent, thick, leafy; leaves fleshier, larger, and deeper-lobed than turnip, not hairy, covered with a bloom which gives a bluish appearance, whitish-green below; larger growth habit; edible maturity reached in 85 to 90 days; somewhat higher than turnips in digestible nutrients.

1. White-fleshed, bronze- or green-topped.
    - (a) Flat-globular type: White Rock, Sweet German.
    - (b) Globe type: Macomber.
    - (c) Elongated, ovoid, or tankard type: White Neckless.
2. Yellow-fleshed.
    - (a) Purple-topped.
        - (i) Globe type: Bangholm, Laurentian, Hall's Westbury (Canadian Gem), Champion, Perfect Model, Magnum Bonum, American Purple Top, Premier, Purple King, Acadia.
        - (ii) Ovoid: Masterpiece, Superlative.
    - (b) Bronze- or green-topped: Ditmars, Lord Derby, Haszard, Invicta, Empire, Kangaroo, Perfection, Hartley, Wilhelmsburger.

The growing of Swede turnips for export has been for many years an important industry in western Ontario, not only for export to the United States, but waxed and graded turnips are shipped to many sections of Canada as well. Close to 95 percent of the acreage used for export is sown to registered seed of the **Laurentian** variety. The other two varieties making up the balance of the acreage being **Perfect Model** and **Purple King.** These last two have too heavy a percentage of large roots if normal moisture is present, but they approximate proper size for shipping if the weather is dry. Under normal conditions registered Laurentian seed produces roots with a high degree of uniformity in size, shape, neck, top, and colour, which allows a heavy percentage of the crop to pass the exacting export grades.

Although registered seed of the Laurentian variety takes up most of the acreage sown in Ontario for table stock, yet there are many other varieties being grown on such a small scale that with few exceptions they do not merit special mention. Swede seed is imported into Ontario from Great Britain, Denmark, and the United States, and at the same time the Maritime Provinces supply heavy quantities. Each of these has its own special varieties, which accounts for the large number of different stocks sold in Ontario. The most important group of varieties as far as Ontario is concerned is composed of those which have been introduced for Canadian conditions, and the seed of which is being harvested in the Maritime Provinces. This takes in such sorts as **Acadia, Ditmars Bronze Top, Laurentian,** and **Wilhelmsburger.**

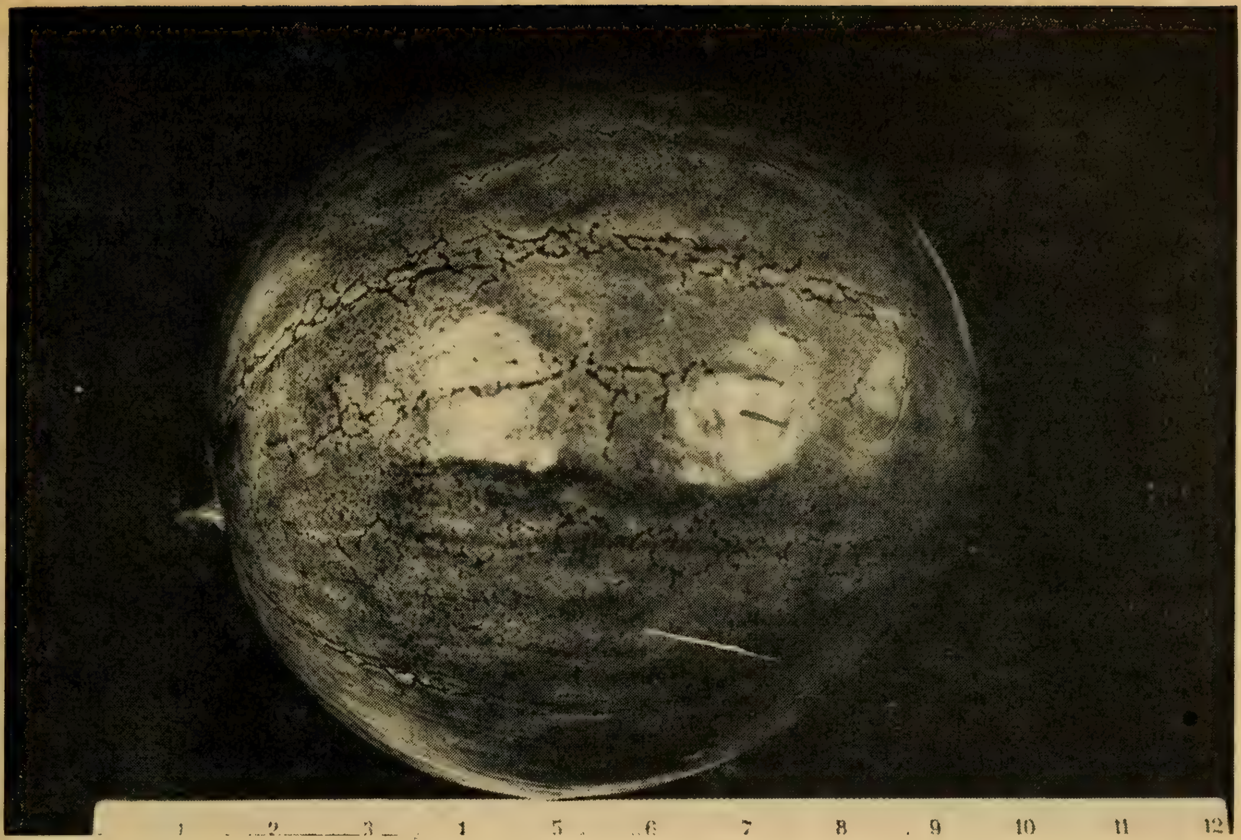


Fig. 49. Early Canada watermelon.

Acadia is not grown in western Ontario as it is not as attractive as Laurentian. It is a heavy yielding dual purpose type grown on a small scale in eastern Ontario both for cattle feed and table stock. **Ditmars Bronze Top** is grown to a slight extent in eastern Ontario. The demand is not heavy as bronze-coloured roots are not popular in Ontario. **Wilhelmsburger** is seldom grown in Ontario as it is a green top variety. In certain districts it has shown resistance to club root.

Canadian Gem comes almost entirely from imported seed. There are many varieties sold under the name Canadian Gem, although the Canadian Seed Growers Association is making a serious attempt at the present time to see that seed of a true stock be produced within the near future.

VEGETABLE MARROW, *see* PUMPKIN

WATERMELON

Ontario can ripen good watermelons including the varieties **Striped Klondike** and **Blue Ribbon.** However, in the case of the warm districts where this is possible, land is too high priced for the growing of watermelons on a commercial scale.

There are in existence and sold in Canada watermelon varieties that will ripen in almost every habitable section of Ontario, even in the warmer sections of Northern Ontario. The earliest watermelon sold in Canadian seed catalogues at present is a yellow fleshed variety known as **Favorite Honey.** This variety is the same size as a muskmelon and averages from 3 to 4 pounds in weight. In order of earliness, other small-sized varieties are **Baby Cream, White Mountain** (red fleshed), **Early Canada, Sweet Sensation, Northern Sweet, Honey Cream** (white fleshed), and **Early Arizona.**

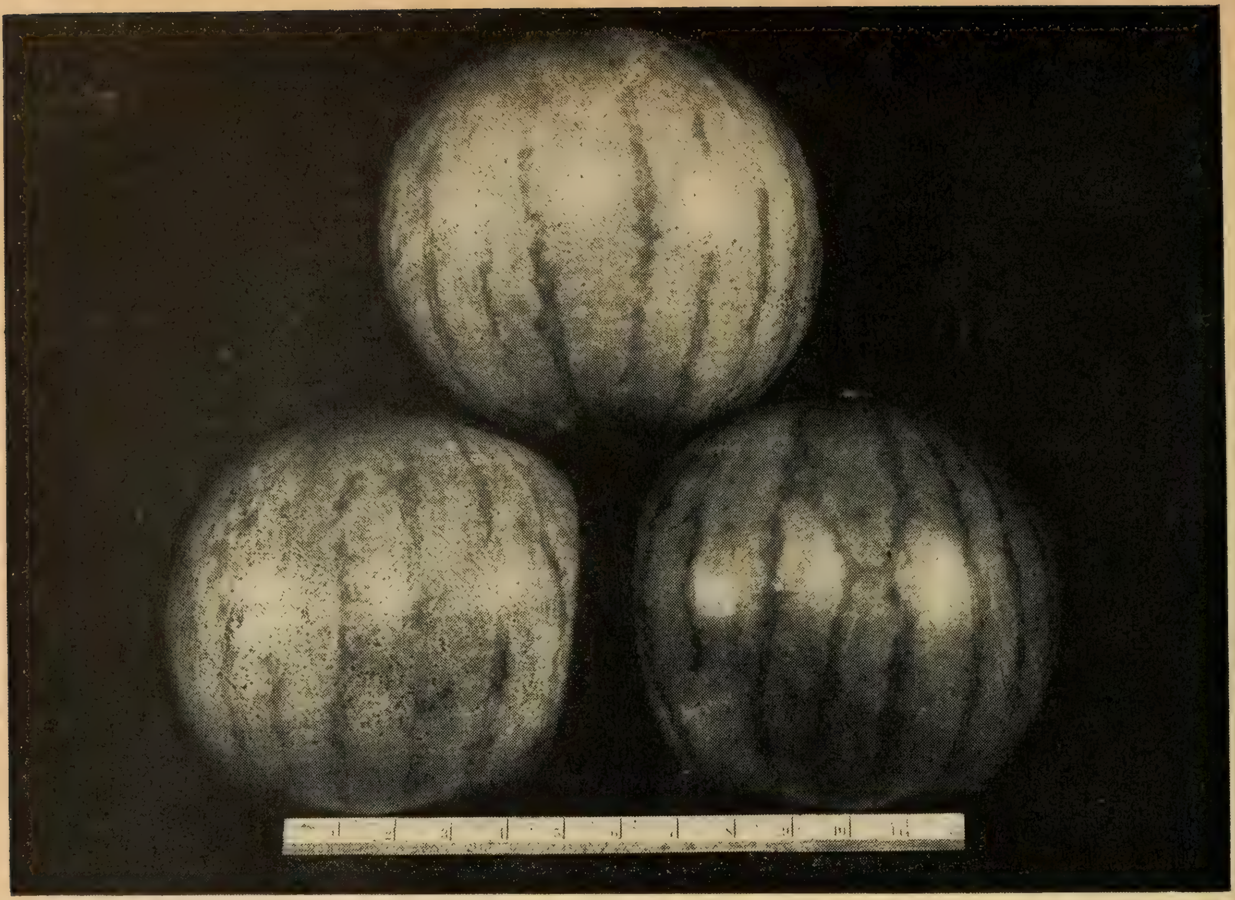


Fig. 50. Ice Box watermelon.

A small sized watermelon known as **King and Queen Winter** is not early but in almost every section of southern Ontario the semi-ripe fruits can be picked and stored in the fall and will ripen slowly during the early part of the winter. It is generally stored in granaries, the fruits being covered by oats, wheat, and so forth.

Catalogues have tended of late to list all small watermelons as the **Ice-Box** variety. This is prompted in part by the fact that watermelons stand up well under freezing. There is actually an Ice-Box variety sold in three separate colours, namely orange, red, and white. However, any small watermelon, such as Early Arizona, Early Canada, or even King and Queen Winter may be sold as Ice-Box or Refrigerator. There has not been time as yet for the value of the small sized melons to be widely known and the selling of several types separately under one name is satisfactory for the present.

There is a medium sized type, oblong in form, which will ripen in practically all sections of southern Ontario. It is sold as a yellow fleshed sort under the name **Sweet Siberian,** and as a red fleshed variety under the name **Early Canada,** not to be confused with the small, round, Early Canada, previously mentioned.

Still larger sized practical varieties are found in **Red Russian** (Improved Cole's Early) and **Kleckley Sweet,** of which there are also improved forms, including **Improved Kleckley Sweet No. 6** which is resistant to fusarium wilt.

ZUCCA MELON

The zucca melon *(Lagenaria siceraria)* is adapted only to very warm districts. The very large, elongated fruits, which may weigh 100 pounds, are useful for preserving and candied peel. It lacks flavour of its own and therefore is more receptive to the artificial colours and flavours. The vines may grow 40 to 50 feet long, and in the warm weather of July may grow 2 feet in 24 hours. Artificial or hand pollination is essential. The first flowers to appear are male, and after about ten of these have appeared the first female flower will be noticed. A simple method of pollination is to take off a male flower and tap the pollen onto the female one. This should be done in the early evening. It is not much use trying to set more than one or two melons per plant. Germination of the seed may be only 50 percent. A transplanting method, with indoor seeding at 70° to 80°F., rather than direct seeding in the garden should be practised.

Acknowledgement. Grateful acknowledgement is made to O. J. Robb, Horticultural Experiment Station, Vineland Station, Ont., for many suggestions in the preparation of this publication, and to the following for the loan of these illustrations: Associated Seed Growers, Figs. 2, 6, 20, 22, 34, 39; Chas. Walkof, Fig. 17; Ferry-Morse Seed Co., Figs. 5, 9, 10, 12, 14, 24, 33, 37; F. H. Woodruff & Sons, Figs. 31, 35; Lawrence Robinson & Sons, Fig. 50; Mutrie & Mutrie, Fig. 32; Northrup, King & Co., Fig. 19; Rocky Ford Cantaloupe Seed Breeders Assoc., Figs. 29, 30; Rogers Bros. Seed Co.. Figs 3, 36; and, to Clarence Edwards for the coloured frontispiece.

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HARVESTING AND STORING OF EAR CORN

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HARVESTING AND STORING OF EAR CORN

INTRODUCTION

The increase in the acreage devoted to the production of grain corn in Ontario in recent years has been outstanding. This change has been brought about largely by two factors: The first is the **introduction of adapted strains of early hybrid corn;** and the second, the development and increasing **distribution of satisfactory machines for the picking and husking** of ripe ears of corn direct from the stalk as it grows in the field.

GRAIN CORN A PROFITABLE CROP

Grain corn is used largely as a feed, but there is an increasing demand for this product for the manufacture of starch, syrups, corn flakes, and associated products.

For the past eight years grain corn tests have been conducted at the Ontario Agricultural College and comparisons made between the yields secured from this crop and from the leading varieties of barley. The average results secured to date indicate that **corn has yielded approximately twice as many pounds of grain per acre as has been secured from barley.**

SECURING A SATISFACTORY CROP

Many crops are made or marred at or before planting time. The following are a few fundamental practices that will go far to ensure a satisfactory crop of grain corn:

(a) Plant early on a well prepared seed bed

A reasonable supply of plant food must be available, and seeding should be done as soon as the soil has warmed up. May 15th to 25th is usually a good time to seed in Central Ontario.

(b) Plant only adapted hybrids

It is much safer and more profitable to plant hybrids that will be sure to mature than to try for a few extra bushels by planting a variety that may be too late for the district concerned.

(c) Do not plant too much seed

Ten to twelve pounds of seed per acre is all that is needed. Two to three plants per hill, or a plant every ten to twelve inches in the row is sufficient.

(d) Keep weeds under control

by cultivation and hoeing. Deep cultivation is not desirable once the crop has become well established.

HARVESTING THE GRAIN CROP

Corn is ready to harvest for grain **when the ears are hard and reasonably dry. The most profitable place to mature grain corn is on the unharvested stalk.**

Mechanical pickers which remove and husk the ears from the standing crop are rapidly becoming the most common and economical way of harvesting corn for grain. Two general types of pickers are available, single, and two-row machines. With these pickers the harvested and husked ears are delivered into a wagon which is usually drawn by the picker.

Hand husking is followed where no mechanical pickers are available. The most common practice is to **husk directly from the standing crop.** The husked ear is thrown directly into a wagon which is drawn alongside the person or persons doing the husking. A special metal hook attached to the hand by means of a leather strap aids in removing the husks.

A further method followed in some localities is to **harvest the mature ears by live stock.** The most common types of live stock used for this purpose are **steers, hogs,** and **sheep.** A ready supply of water and some available source of protein concentrate are desirable for this method of disposing of the corn crop.

DISPOSAL OF THE CORN STALKS

Where a mechanical picker has been used, or hand picking followed, the corn stalks remain and must be disposed of. **The most satisfactory way of disposing of corn stalks at present is to plough them under.** This can be accomplished satisfactorily if the stalks are broken down with a disc, packer, cutter, or other suitable implement before ploughing. Both the breaking down and the subsequent ploughing should follow the direction of the rows. A plough with good clearance and with a notched roller coulter is very satisfactory for the purpose, and a furrow at least 12″ wide and 5″ deep is desirable for good coverage.

There is an increasing interest in the industrial use of corn stalks. Further development of this idea might well result in a sufficient demand for this product to make the removal and sale of the corn stalks a profitable venture.

DRYING AND STORING THE CROP

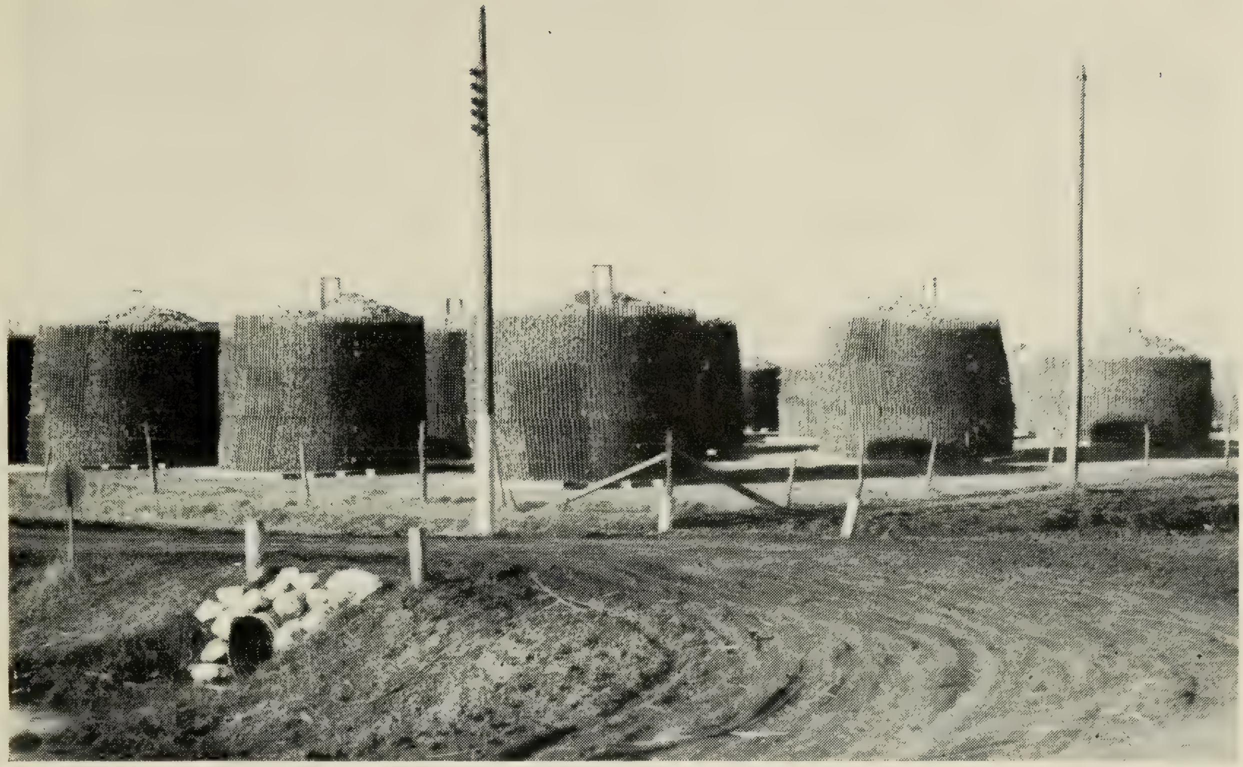
A. Where the crop is to be used as feed

Most hybrid corn harvested for grain is used as feed. The proper handling of this product is one of the problems of both new and old growers.

The cheapest and best place to dry corn for grain is on the standing stalk. Where early planting of an early maturing variety for the district has been practiced, little difficulty should be experienced in drying corn satisfactorily in the manner suggested.

The harvesting of grain corn can be delayed until other crops have been removed from the fields, hence there is little interference with other harvesting operations.

Some type of corn crib is usually used for storing the harvested ear corn. Such structures are of various shapes and sizes, but have a common requirement of slatted sides and some ventilation underneath.



Cut No. 1: A temporary type of crib made of snow fence. Centre ventilators speed the drying of the corn. (Courtesy Manitoba Dept. of Agriculture)

A temporary type of crib has been used rather extensively in recent years. This consists of using a base of old fence rails or posts to provide ventilation underneath and to keep the ears off the ground. On top of this base a temporary round container is erected of snow fence material, usually two or three sections in height and from five to eight feet in diameter. The first section is usually filled before the second one is added. An overlap of around one foot holds the sections together when filled.

If the moisture content of the corn is high when harvested it is safer to limit the diameter of the crib to around five feet, and the height to two sections of fence material. Some growers **use a ventilator in the centre of the crib** to ensure better circulation of the air. This is particularly desirable where cribs of the larger diameter are used.

These temporary cribs are frequently left open at the top. However it is safer and usually more satisfactory to provide some type of temporary covering.

A second type of crib which might be termed "semi-permanent" is finding favour with a number of growers. The essential features of such a crib are straight walls, about five feet apart, the basis of which is a series of cedar posts of approximately 6″ in diameter. These are around 16′ long on the front side of the crib and around 14′ long on the back portion. They are placed in the ground about 2½ feet and are spaced at 4′ intervals. They support a slanting roof with an overhang of around a foot on all sides. The boards comprising the roof may or may not be covered with asphalt roofing material.

About a foot from the ground 2 x 4′s nailed between each pair of posts support a plank floor. The side walls are made of snow fence, three sections high including the overlap. The ends are boarded up leaving openings between the boards, or else closed with a snow fence with the slats running crosswise instead of up and down.

Each pair of posts is tied together, at around half their height, by a twisted wire brace. This adds materially to the strength of the crib and its resistance to outward pressure.

The crib is filled to about a ten-foot level, and it is claimed that each twelve foot section of such a crib contains approximately 6½ tons of shelled corn.

A handy type of conveyor for filling the crib is illustrated in Cut No. 4. A ¾ H.P. motor drives the elevating portion, and ear corn can be handled very effectively and cheaply by such a machine. It has been suggested that the addition of a slotted slide between the conveyor and the crib would improve the loader in question. Such a slide would separate the hulled kernels, and at least a portion of loose husks from the ears, and thus help to prevent excessive packing of the area immediately below the delivery end of the conveyor.

A more permanent type of crib has been in use in many areas for the storage of ear corn. This is usually constructed with either one or both sides sloping, which ensures greater width at the top of the crib than at the bottom. Usually the bottom, sides, and ends are all constructed with siding spaced 1″ apart. Some growers prefer to have a solid floor. Cut No. 3 (supplied through the courtesy of the Agricultural Engineering Department) illustrates the general method of constructing such a crib.

The foregoing is a description of some of the common methods of storing ear corn. However, some growers use other kinds of available space to advantage. The chief requirement for successful storage is some facility for good air movement in the stored corn. Rather shallow piling of the ears aids in this connection.

A satisfactory corn crib should possess the following characteristics:

1. Good ventilation.
2. Protection against outside moisture.
3. Protection from rodents.
4. Permanency.
5. Some convenient means of filling and emptying.

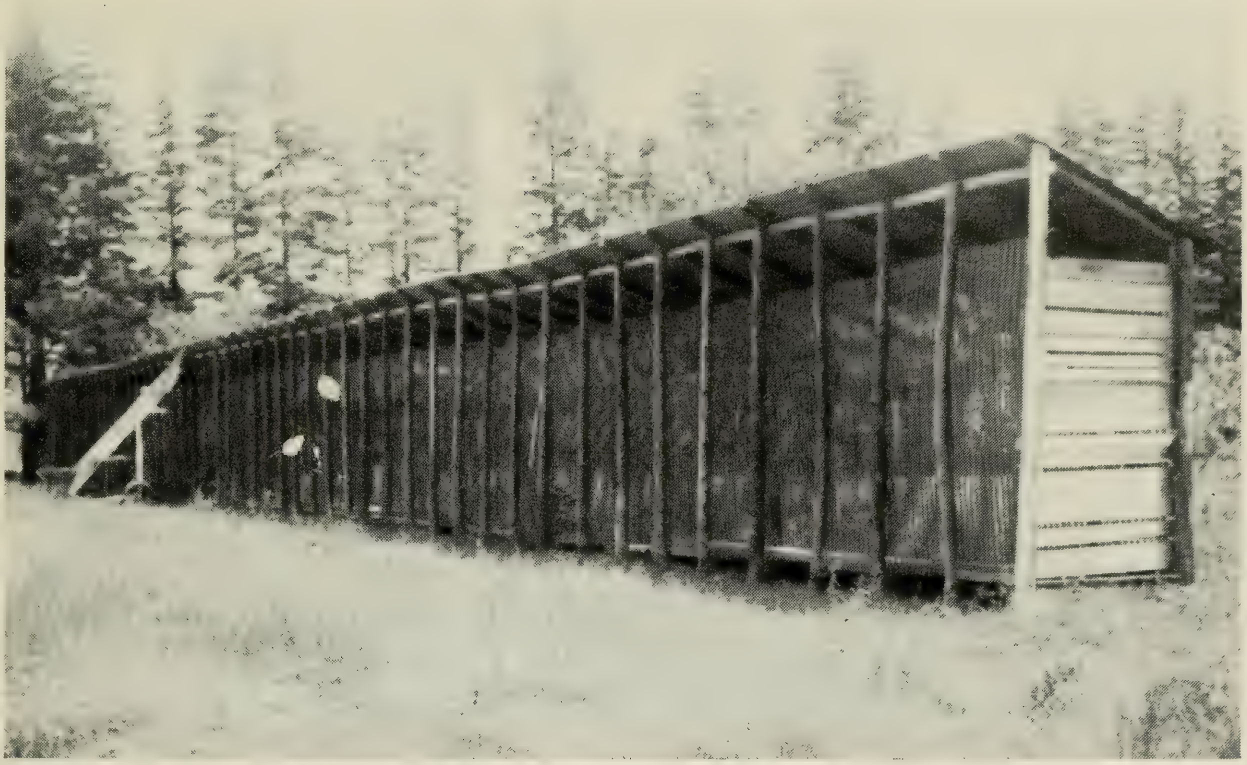
Ear corn, although apparently well cured, sometimes heats and goes out of condition under the very high moisture conditions usually obtaining in the early spring. With corn intended for holding through the late spring or early summer the safest practice seems to be to shell it in the latter part of the winter and store in a grain bin.

Where ear corn must be stored in that condition the sides of the crib can be sealed in the late winter months. This will tend to prevent excessive absorption of moisture in the early spring.

B. Where the harvested crop is intended for seed

Damage From Low Temperatures to Corn Intended for Seed

In experiments conducted at the Ontario Agricultural College it was found that **damage to germination from freezing was correlated almost directly with the moisture content of the ear and the duration of the exposure to cold.** An interesting feature of the data secured was the greater



Cut No. 2: A semi-permanent type of corn crib that is giving satisfaction.

damage experienced when fluctuating rather than steady temperatures were employed. This finding appears to be in accord with the opinions of corn growers who report greater damage to germination from repeated drops in temperature rather than from a continuous cold period.

On the whole it would appear that corn stored with more than 20% moisture was very likely to suffer severely in its germinating ability in the event of any serious drop in temperature.

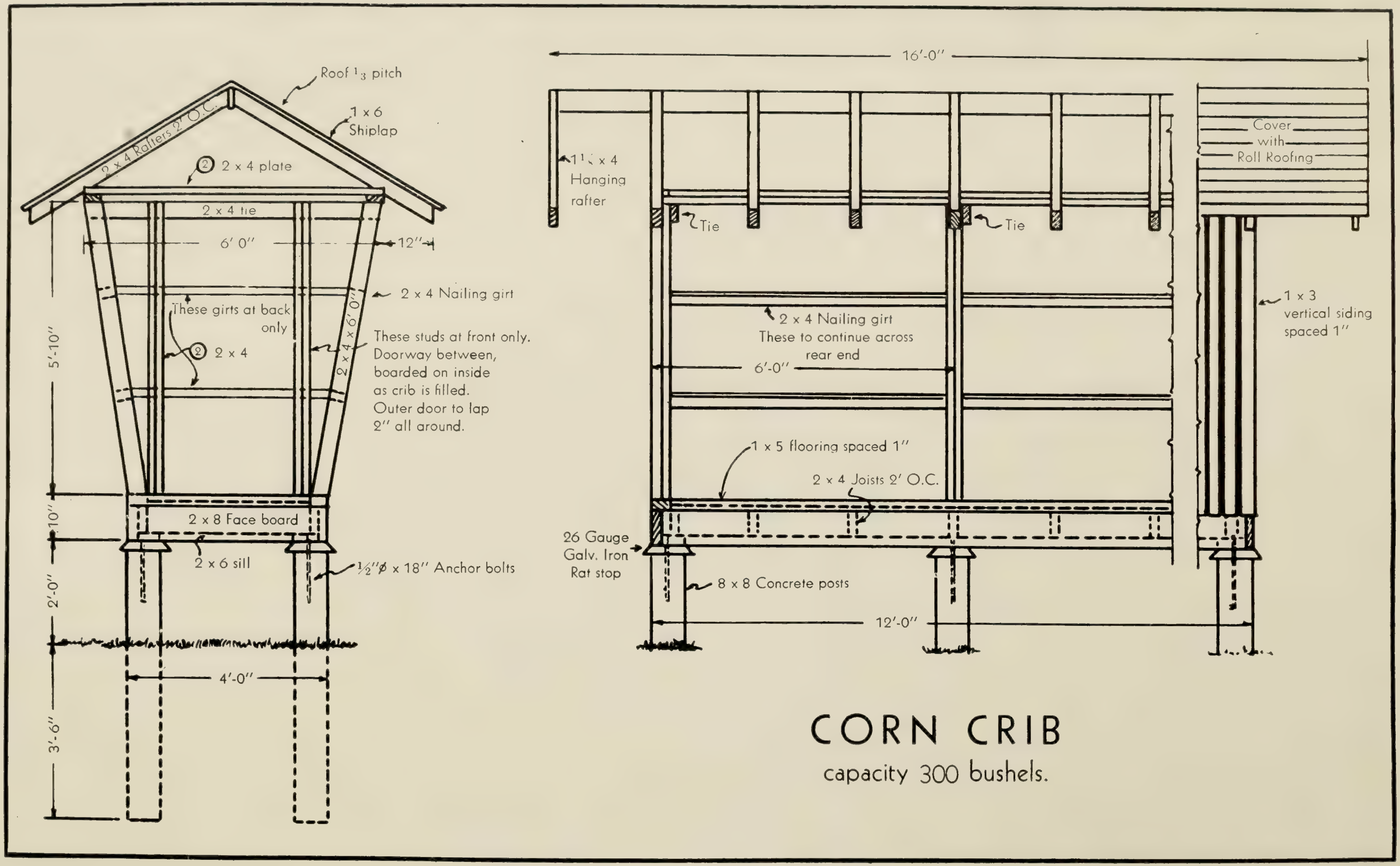
Both flint and dent corns were used and no appreciable difference was obtained between the reactions of the two types.

To be quite safe corn intended for seed should be well below 15% moisture before storing. This necessitates ripening as well as possible on the stalk and in most instances some additional drying of the harvested ears by artificial means.

DRYING EAR CORN INTENDED FOR SEED BY ARTIFICIAL HEAT

In earlier days when the quantity of seed corn handled was much less, a good deal of drying was done on frames of various kinds. The ears were kept from touching each other and thus permitted free circulation of air all around them. Drying was facilitated and unless unduly low temperatures were encountered seed of satisfactory germination was secured.

Chicken wire nailed on either side of 2 x 4 upright sections, spaced from two to three feet apart, constitutes a common type of rack for drying seed corn. The husked ears are placed through the meshes of the chicken wire in such a manner that they do not touch each other. Another common method of handling small quantities of seed corn is to drive finishing nails into posts, leaving about an inch-and-a-half of the nail protruding. The butts of the ears are shoved



Cut No. 3: A good type of permanent corn crib.

Cut No. 4: Filling the corn crib is a simple job with a loader of the type illustrated.

onto the nails, which are spaced at intervals about the width of the diameter of an average ear.

Wire trays containing thin layers of ears are also used. These trays are of any convenient size and are held in racks which permit the spacing of the trays sufficiently far apart to assure a good circulation of air.

With all such equipment the drying may be speeded up by providing facilities for using artificial heat. In recent years the use of artificial heat in drying seed corn has become much more common.

Various types of driers have been developed, but the main methods used have much in common in the case of all driers. **Practically all corn is dried on the ear and is placed in a container in such a manner that warm air can be circulated quite freely through the drying bins.** Frequently there is provision for circulating the air either up through the bins or down through them. With such equipment the common practice is to circulate the air alternately one way and then the other during the drying process.

The temperature of the air used in drying ear corn for seed purposes has been 105°F–110°F. This temperature can be safely used with most corn. However, extensive tests conducted at the Ontario Agricultural College indicate that the degree of heat that can be used safely depends largely on the moisture content of the ears which it is intended to dry. Where a moisture content of 45% to 50% is encountered the drying temperature should not exceed 105°F. However, such high moisture content is seldom found and most years the ears of suitable sorts of corn can be dried on the stalk to around 25 to 30 per cent moisture. With, and below this range of moisture our experiments indicate that temperatures as high as 130°F can be used without any injury to the speed or vigor of germination. The higher temperatures dry the corn more rapidly and cheaply.

The interior of an ear of corn when subject to drying temperatures is considerably cooler than the air surrounding the ear. The extent of this difference is determined by the moisture of the corn when drying commences and by the temperature of the air used for drying. As the moisture content of the ear is lowered, the interior temperature approaches more closely to that of the temperature of the air surrounding the ear. This lag in temperature of the interior of an ear of corn near where the germ end of the kernel is located is one of the reasons why little damage to germination occurs at the higher range of temperatures suggested for drying.

SHELLING THE DRIED CORN

Whatever the means used for drying corn on the ear, once this has been accomplished the corn is usually shelled. Shelled corn can be stored more economically and conveniently than ear corn. It is also much less subject to variations in moisture content due to climatic conditions than is the ear corn.

Various makes of both hand and power shellers are on the market, and a satisfactory job of shelling can be done with any of these. The chief consideration is to maintain both the speed and adjustment of the shelling devices so that the minimum amount of cracking of the kernels occur and a clean job of shelling results.

CAPACITY OF GRAIN BINS

To calculate the capacity of grain bins in measured bushels, divide the volume of the bin in cubic feet by 1.2843.

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THE OAT NEMATODE

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BY J. LAUGHLAND
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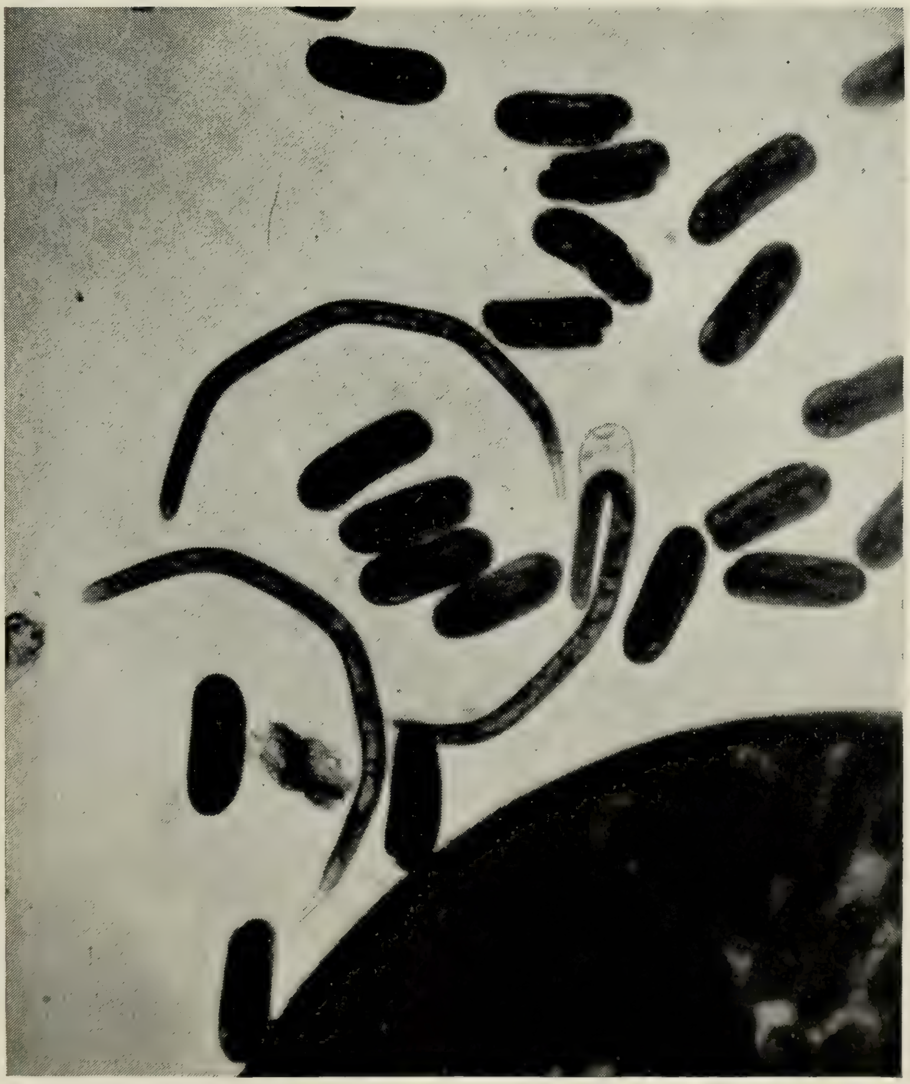


Nematode Larvae, Eggs and Part of a Cyst, (greatly enlarged)

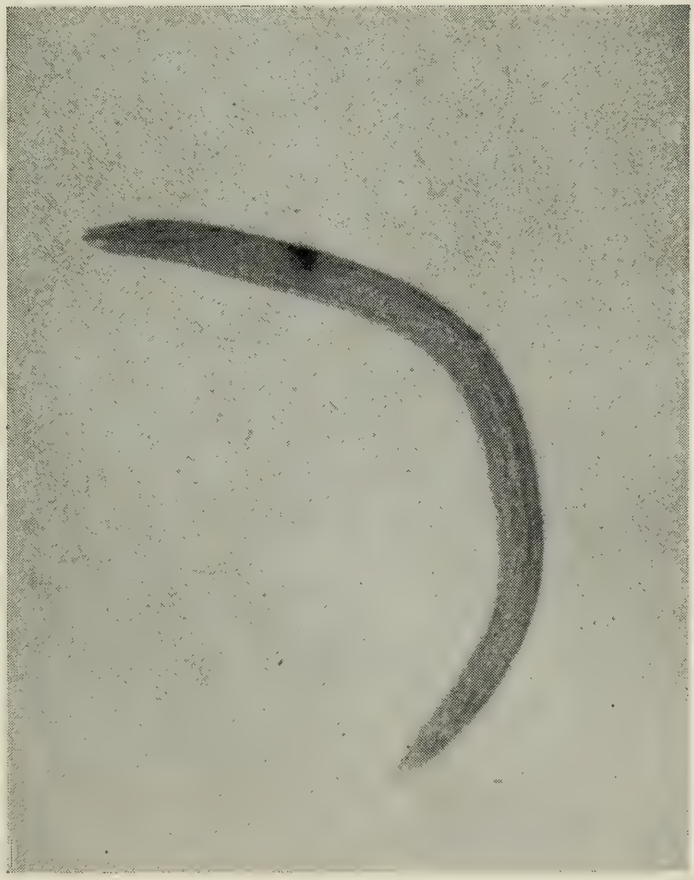
ONTARIO DEPARTMENT OF AGRICULTURE
Statistics and Publications Branch
Toronto, Ontario.

BULLETIN 453 SEPTEMBER, 1947

THE OAT NEMATODE

(Heterodera schachtii)

Every grain grower in Ontario should have some knowledge of the oat nematode. This pest has been known to exist in certain sections of the province for the past fifteen years. Nobody seems to know how it got here or exactly when it arrived. In some parts of Europe oat nematodes were investigated seventy-five years ago. One of the first nematode outbreaks in Ontario was studied by representatives of the Ontario Research Foundation about 1933. Later on in another area where nematodes had caused damage the Ontario Agricultural College conducted experiments on an eight-acre field for a period of five years.



A Nematode Larva

These investigations proved that losses from the oat nematode have been greatly reduced by changed farming practices. Some farmers whose oat crops were almost ruined by nematodes are now following different cropping practices and experiencing little or no difficulty.

Nematode damage varies from year to year. It is always worse in wet, backward seasons. When it does occur the losses will be greatest in fields where the normal growth of oats has been hampered by lack of soil fertility, poor preparation of land, or other handicaps.

Grateful acknowledgement is made to Professor E. H. Garrard of the Department of Bacteriology, Ontario Agricultural College, and Mr. C. H. Castell, formerly of that Department, for taking many of the photographs included in this bulletin, and to the Public Relations Department for making prints.

LOSSES

Many farmers whose oat crops have been reduced in yield by oat nematodes have not been aware that this pest was on their farms. They attributed the low yields to unfavourable weather, poor seed germination, insufficient soil preparation, low fertility, or some other cause. Nematodes at work in a grain field are not easy to detect, but bad infestations may reduce the crop to almost nothing. Even where the injury is scarcely noticeable in the field there may be a reduction of several bushels per acre in the yield of oats.

Some of the reasons for the reduced yield were brought out during the investigations. Oats grown on infested land had roots only ¾ of an inch long on June 4th, while those on an adjacent plot which had been in a rotation had roots 2¾ inches long. There was an average of only 24 kernels to the panicle on the oats in the infested plot, but the average was 46 where the oats were in a rotation.

Nematode Infested Oat Fields are Patchy

THE SPREAD OF NEMATODES

Oat nematode damage has been observed on grain from fields in the following counties: Brant, Bruce, Dufferin, Grey, Haldimand, Halton, Kent, Norfolk, Ontario, Oxford, Peel, Perth, Simcoe, Waterloo, Wellington, and York.

It is not known how nematodes arrived at so many widely scattered points. They have no means of locomotion which would enable them to get far from the place they originate. Some no doubt are carried on the wheels of implements or spread by water over land that is subject to flooding.

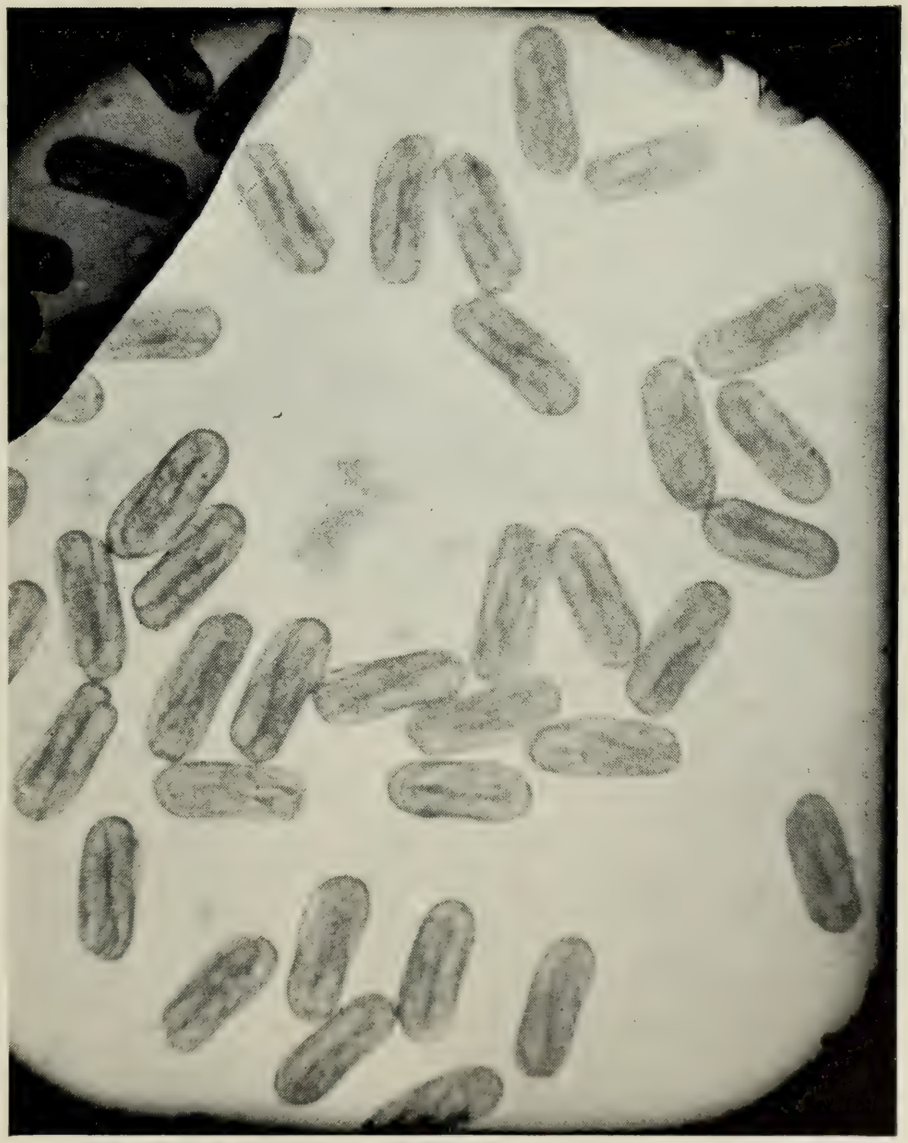
The finding of nematodes on oats at so many places does not indicate widespread damage, but it should cause farmers to observe their fields closely for any possible outbreaks.

WHAT ARE NEMATODES?

There are many kinds of nematodes, or eelworms. Some are found as parasites in animals and others live on plants. Most of those that attack plants are tiny, worm-like creatures, so small that they cannot be seen with the naked eye. Although nematodes resemble worms, their structure is quite different from that of earthworms or wireworms and they are grouped zoologically in a different phylum.

Some kinds of nematodes can be found feeding on dead vegetation from the field or garden. Others carry on their activities within or on the living tissue. The oat nematode is one which attacks the growing plant and is usually found in the roots or near the base of the stem.

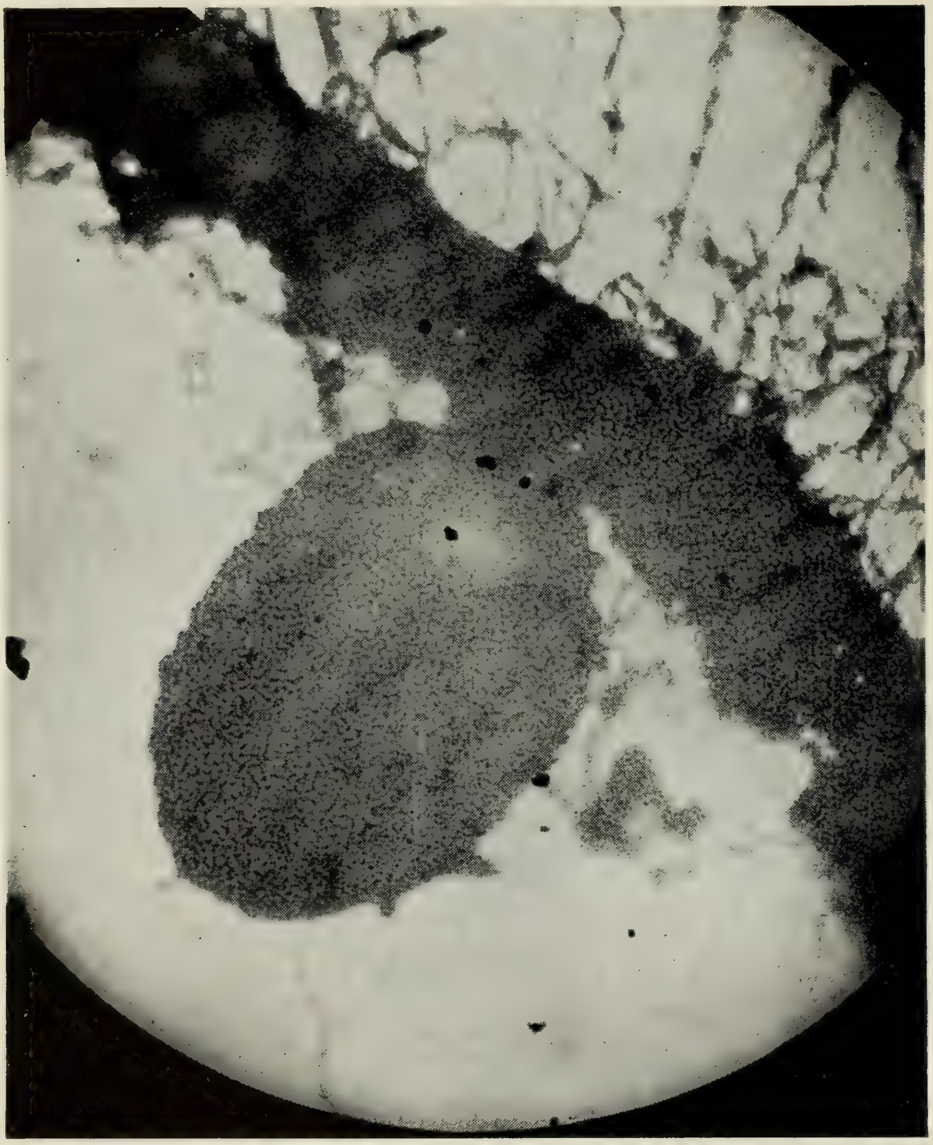
It is hoped that the photographs will help to acquaint the reader with the nature of this parasite. The damage it does to the crop is much easier to see than the nematode itself.



Nematode Eggs

LIFE HISTORY

A microscopic examination in early spring of the top soil in a field that grew nematode infested oats the year before will reveal the presence of brown cysts containing larvae, or there may be free larvae in the soil. The larvae attack the young oat plants and enter the developing roots. After feeding for about ten days they moult and continue their feeding for another ten days. Then the two sexes develop differently. The males remain worm-like and after about two weeks leave the roots and live in the soil. The females enlarge and become lemon-shaped. This increase in size forces them out of the roots but they remain attached to the roots by the head. These female cysts are white at first and turn brown later. During four years of study white cysts were first observed on oat roots on the following dates: June 24th, 23rd, 26th, 20th. The most white cysts were found about the middle of July, and by August 1st many of them had turned brown.



A White Female Cyst Attached to Oat Root

Each white cyst contains oval-shaped eggs which hatch into larvae usually after the cysts have turned brown, although sometimes white cysts will contain hatched larvae as well as eggs.

Small white cysts contained about thirty eggs, while the large ones had more than five hundred eggs in a single cyst.

Cysts can sometimes be found on roots of oat stubble after the crop is harvested. They remain in the soil over winter to start a new outbreak of nematodes the following spring if conditions are favourable.

DETECTING NEMATODE DAMAGE

First-Noticed

On land badly infested with oat nematodes the grain will usually appear quite normal when it comes through the ground, but about a week or ten days later it will begin to look sick. If inspected at intervals of a few days it will seem to be making little or no growth. The plants stand erect instead of having the usual wavy appearance of healthy grain. Tips of the blades begin to turn reddish in colour. Later a large part of the upper leaves become yellow, and withered. The grain will stool very little or not at all, and the field will maintain a backward appearance.

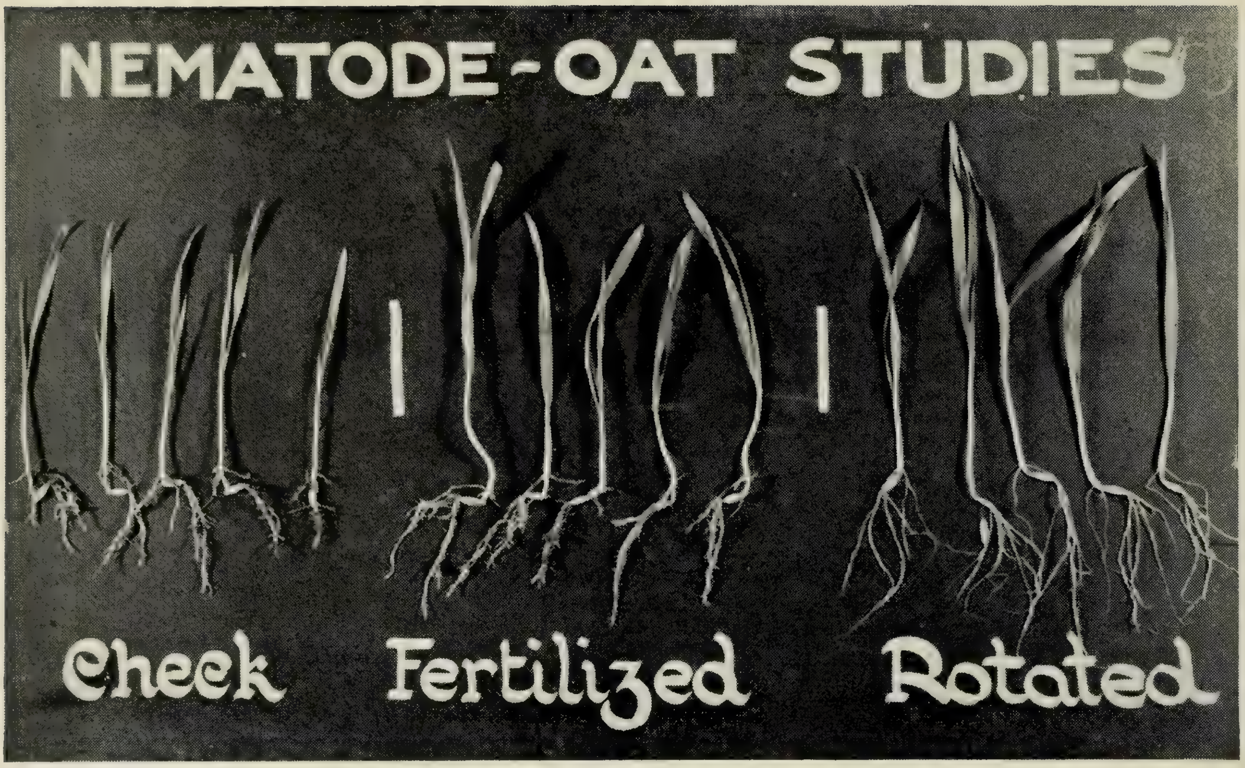
A Mature Brown Cyst

Injured Roots

If some of the oat plants are dug up when the grain is three or four inches high the roots will be short and stubby with an undue amount of soil clinging to them. They will also show much branching. The roots of healthy oat plants at the same stage of growth are long and straight with comparatively little branching. Infested roots usually have a yellowish colour, while healthy roots are white.

Female Cysts

The presence of white cysts on the oat roots from the time the grain heads out until about harvest time is one of the surest indications of nematode damage. These white, lemon-shaped cysts are female nematodes containing eggs. They can be pushed from the small roots of the oat plant with the point of a jack-knife. If a cyst is laid on a smooth surface and crushed with the point of a knife a small amount of liquid will spurt out of it. This liquid, if examined under a microscope, will show nematode eggs floating in it. The white cysts vary in size. They can be just nicely seen with



Branched Nematode Infested Roots on Left and Straight Roots of Healthy Plants on Right

the naked eye. When looking for them the oat plants should be carefully taken up and the roots dipped in a pail of water to remove the earth and expose the cysts.

Uneven Growth

There are several things that could cause a field of oats to be patchy, but the possibility of nematode damage should not be overlooked. If there are thin spots in the field, or a noticeable difference in the size and vigour of plants, nematodes might be suspected. Another indication would be oat plants that never head out, or those that have only a few grains on each head.

Weed Patches

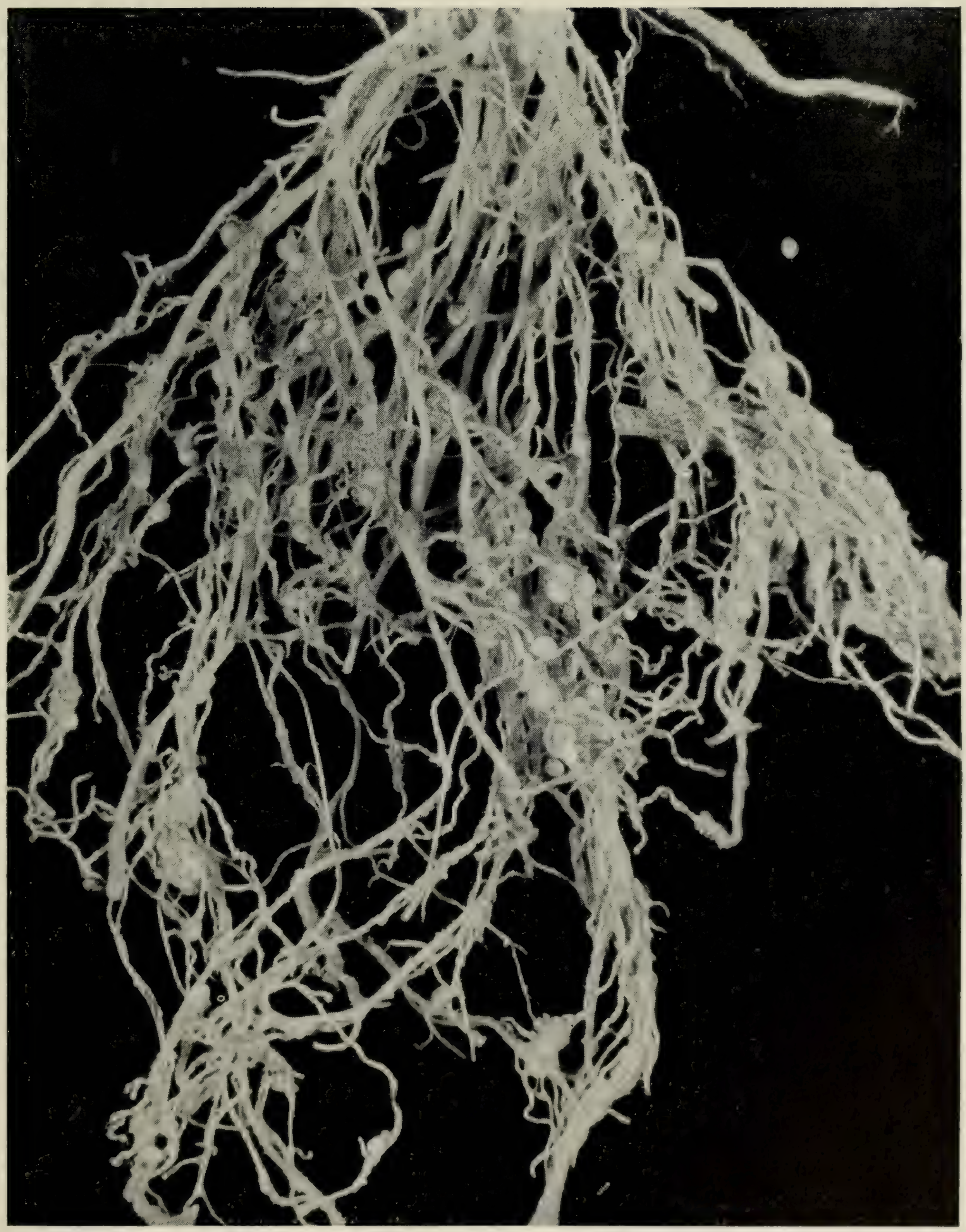
Nematodes do not as a rule injure an oat field uniformly over the whole area. There may be places where the oats are good. Usually, however, there will be areas where the crop is nearly all killed out, or stunted. In such patches there is often an abundance of weed growth. Weed patches in the oat field should arouse the owner's suspicions.

Oats Disappear First

A field of mixed grain that is infested with nematodes will sometimes head out showing patches where there is only barley. The oats may be so badly affected that they never head out. Generally speaking, the oats in mixed grain are taller than the barley, but if they are badly infested with nematodes their growth may be much retarded.

METHODS OF CONTROL

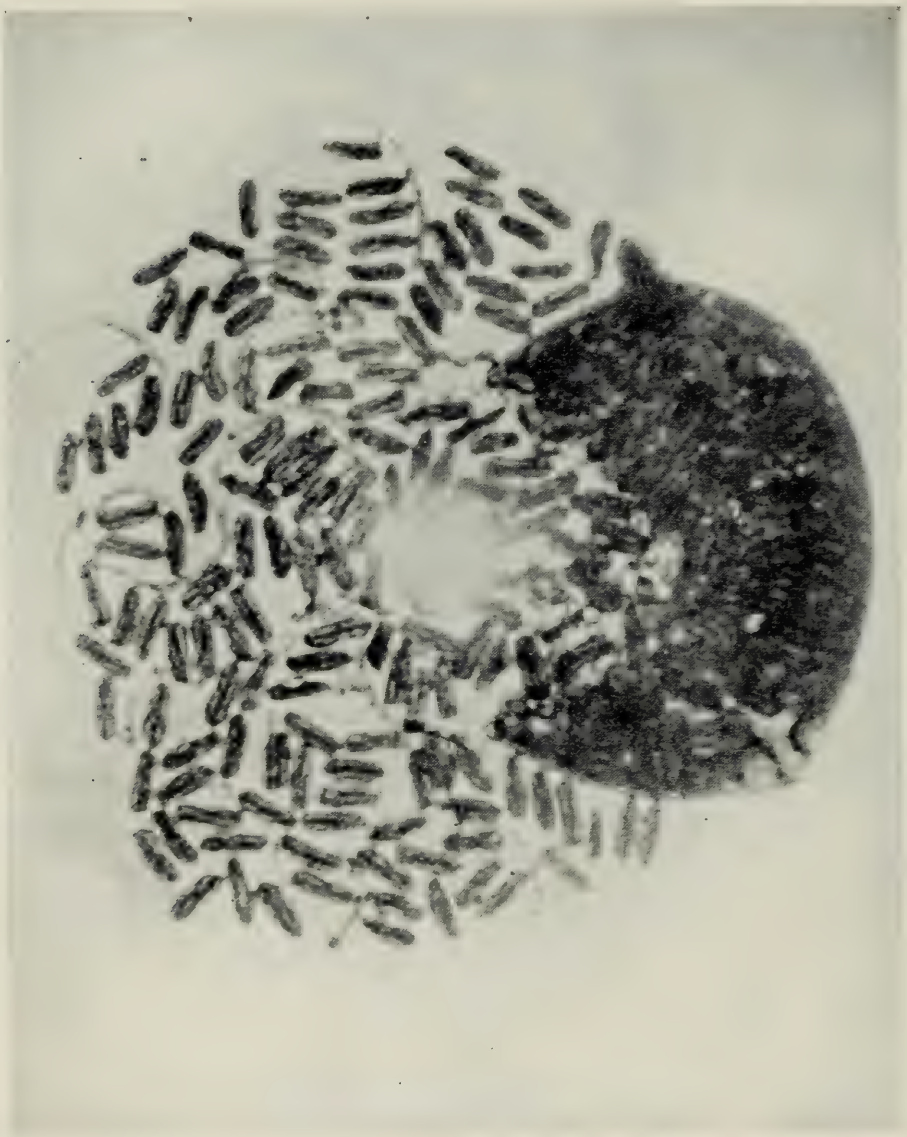
It may not be possible to entirely eliminate the oat nematode, but there is every chance of reducing its numbers to a degree that will permit the growing of satisfactory oat crops. These worms prefer oats, but they will attack barley, wheat, and several kinds of weeds such as Lamb's Quarter. Some of the worst nematode damage has occurred where spring crops followed each other too closely and gave the nematodes a chance to multiply.



Root of Oat Plant with Many Nematode Cysts Attached

Crop Rotation

A good crop rotation is the first essential. When nematodes are found in a field it is advisable to drop oats, barley and spring wheat for at least three years. Longer would be better. The field may be seeded down and used for hay or pasture for two or three years. Then, it could be broken up and devoted to corn, roots, peas, soybeans or buckwheat for one or more years. By that time, the nematode population would likely be sufficiently reduced to permit the growing of oats again. Fall wheat has not been affected to any great extent by nematodes although they have been found on it.



One Cyst will Contain an Average of 250 Eggs

Control of Weeds

It is known that some weeds will act as hosts for oat nematodes and keep them alive even if there are no oats near. This points out the necessity for keeping land free from all weed growth which might harbour nematodes.

Another reason for keeping weeds down is that they stunt the growth of oats. Weakened plants will not resist nematode attacks. Early cutting of hay, the use of smother crops, and thorough cultivation of root land will help to control weeds.

A Field of Mixed Grain with a Nematode Infested Area on the Right Where Most of the Oats Have Been Killed Out

Shallow Ploughing

Shallow ploughing is advisable where nematodes are known to be present in the soil. Manure, grass roots, stubble or straw should be kept near the surface. This material, even on an old sod field, can often be worked into the top soil with the one way disc in preparing the land for a crop.

Fertile Soil

A well fertilized crop of oats has larger and stronger roots than one that is poorly nourished, and is in a better position to keep on growing when attacked by nematodes. A good supply of organic matter in the soil is advisable. A soil test should be made so that any lack in fertility may be corrected by applying the right kind and amount of manure and fertilizer. Manure will give better results if applied in small amounts at frequent intervals, rather than by heavy applications less frequently.

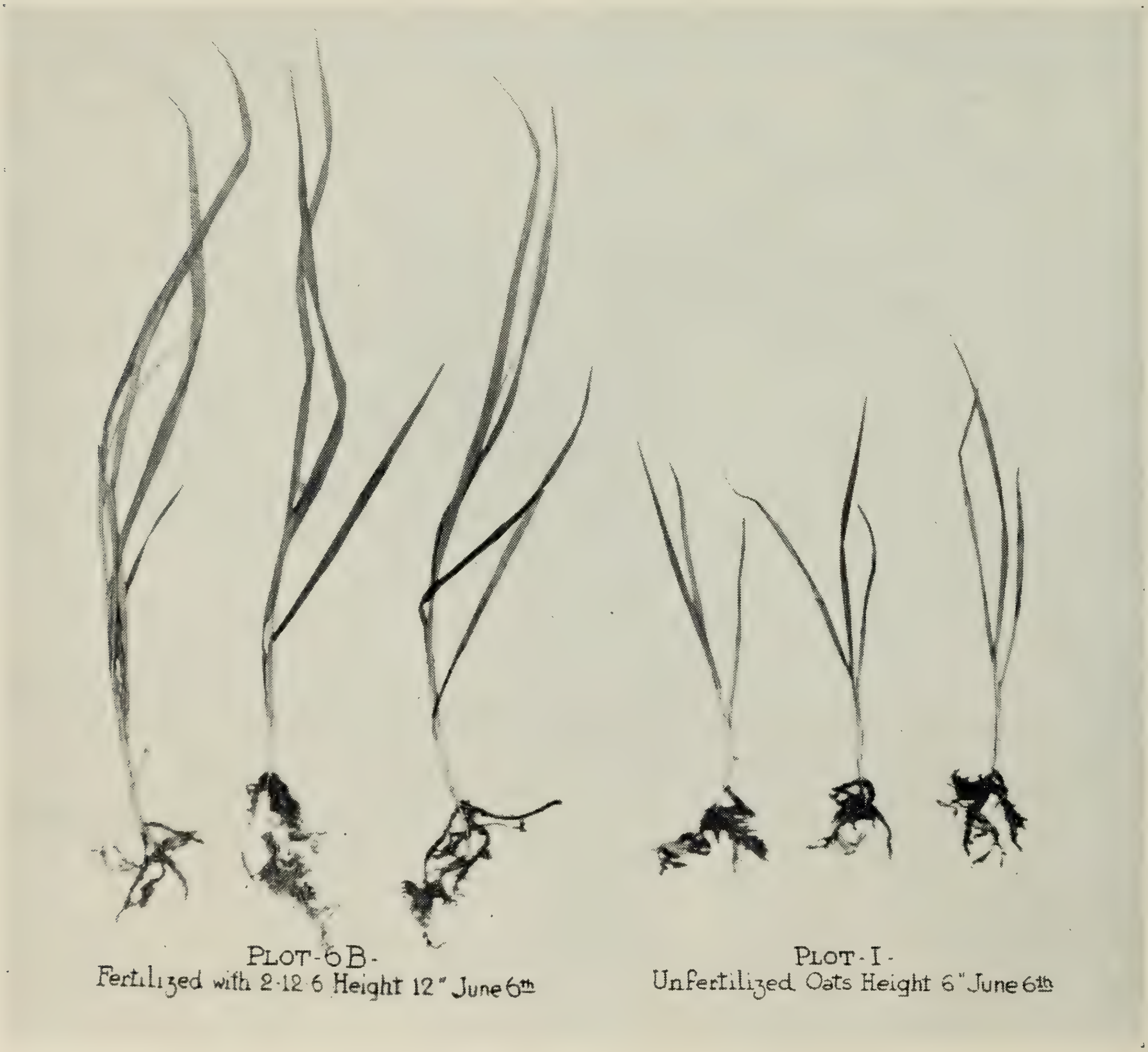
Good Seed

It is good practice to use large, plump, well-graded seed oats at all times, and if there are nematodes in the land on which the grain is to be sown, certainly nothing but the best seed should be used. Treating the seed against smut and root rot may produce healthier plants and indirectly give the oats greater resistance to nematodes.

Varieties of Oats

There may be a difference in the resistance of oat varieties to nematode attacks. Information on this point is difficult to obtain. The investigator may plant a series of varieties on infested soil, but he cannot be sure that an equal number of nematodes will invade each plant.

Natural forces probably assist in keeping nematodes in check. It may be that many of them perish in winters of severe frost. Some farmers have noticed that on the hilltops where the snow drifted off and the frost went down there was not so much injury the following spring. In one case the nematode damage was much greater where a snow fence had held the snow and protected the ground from frost. Nature no doubt is of great assistance in maintaining a proper balance, but when nematodes are present it is good business for the farmer to give nature all the co-operation he can.


PLOT-6B-
Fertilized with 2-12-6 Height 12" June 6th
PLOT-I-
Unfertilized Oats Height 6" June 6th

Fertilizer Helps to Promote Growth of Infested Oats

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OATS AND BARLEY IN ONTARIO

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By ROBERT KEEGAN and D. N. HUNTLEY
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ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 454 JANUARY, 1948

OATS AND BARLEY IN ONTARIO

by

R. KEEGAN and D. N. HUNTLEY

THE IMPORTANCE OF OATS AND BARLEY IN ONTARIO

Oats and barley are the most important spring grain crops grown in Ontario. The following table shows the relative importance of oats, barley, and mixed grains which consist largely of barley and oats sown together.

*Ontario Annual Averages for the Period 1936 to 1945**

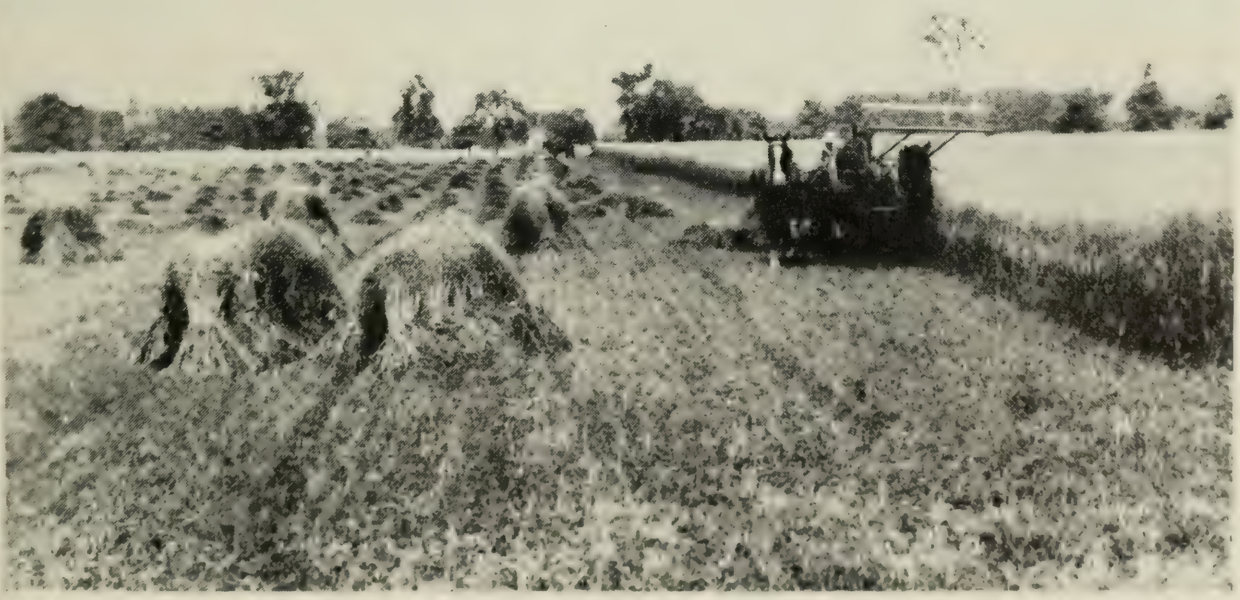
Crop	Acreage	Bushels
Oats	2,052,690	70,016,525
Barley	427,212	12,843,190
Mixed Grain	971,040	34,585,624

Barley usually outyields oats in a mixture. Therefore the bushels of mixed grain shown in the table probably consist of more than half barley. This indicates that the production of barley in this province is more than double the amount shown by the figures for barley as a pure crop.

*From the Annual Report of the Statistics Branch, Ontario Department of Agriculture, 1946.

During the ten-year period, 1936 to 1945, in Ontario, barley has produced 308 pounds† more digestible nutrients per acre per year than oats. Barley produced an average yield of 1,440 pounds of grain per acre, compared with 1,154 pounds of oats. The total digestible material in the grain is seven to eight pounds per hundred more in barley than in oats.

†According to analyses in Feeds and Feeding, F. B. Morrison, The Morrison Publishing Company, Ithaca, N.Y., 1936.



The growing of varieties adapted to local soil and climatic conditions results in higher yields.

Test plots of Barley and Oats, such as the one shown above, indicate which varieties are adapted to a district. Similar tests are now located in almost every County in Ontario.

While barley is a more efficient producer of feed grain than oats there are several reasons why it is less popular as a farm crop:

1. The rough awns on some varieties cause discomfort to workers who handle the crop, and are objectionable when the straw is fed to livestock. This difficulty has been overcome by the development of varieties with smooth awns.

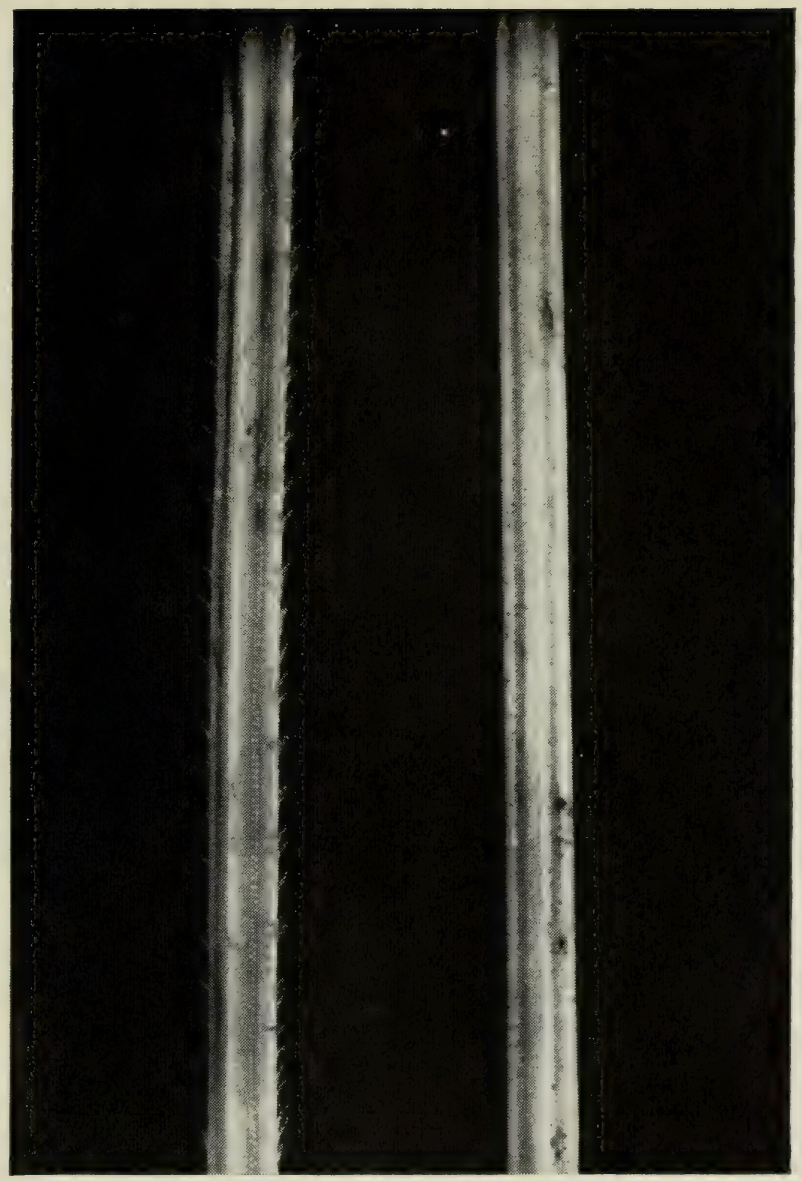
2. Barley does not yield as well as oats on soils of less than average fertility.

3. The oat crop is preferred when straw is used as a roughage for livestock.

OATS AND BARLEY FOR LIVESTOCK FEED

Oats

The grain of oats has a higher proportion of protein to carbohydrates than barley, and therefore is preferred as a feed for growing animals. Because of its higher fibre content and heavier hulls, oats is not a good feed for young chicks or very young pigs, unless the hulls are removed, or a hulless variety used. It is a good grain in ground mash for ruminant animals, because the hulls give desirable bulk. The addition of ground oats to a ration containing heavier grains makes the grain mixture bulkier and less liable to cause digestive troubles in cattle. Oats is considered to be an excellent feed for horses.



BARLEY AWNS MAGNIFIED TWELVE TIMES

Rough Awn Showing Barbs *(Left)* **Smooth Awn Showing Absence of Barbs *(Right)***

Barley

In Ontario barley occupies the same place in grain rations that is taken to a great extent by corn in many areas of the United States. It may be fed to all kinds of farm animals as part of the concentrate ration, and usually gives best results when combined with lighter feeds such as ground oats or bran, especially when animals are being fed heavily on grain. The proportion of barley may be increased in a mixed grain ration for fattening animals, as it contains a higher percentage of carbohydrates than oats, with which it is usually fed.

Barley fed to growing and to fattening hogs produces an excellent quality of ham and bacon. It is especially important at the present time that the use of this feed be maintained, or, when possible, increased in our hog feeding program, as there is a ready market for Canadian bacon and pork products in Britain. Feeding for quality will be the best method of retaining our share of this market, if we find increasing competition with other bacon-producing countries in the export trade.

A field of O.A.C. 21 Barley. This variety has been considered the standard for malting quality in Canada.

Oat and Barley Straw

Oat straw is the most nutritious of any of the cereal crop straws. It provides roughage in maintenance rations for horses, cattle, and sheep. It may be used as part of the roughage for producing animals (breeding, fattening, or milking) if balanced by satisfactory grain rations.

Barley straw is not as popular a roughage for livestock as oat straw, as it is less nutritious. It is a more valuable roughage than the straw of wheat and rye. The use of smooth awned varieties will provide straw that is less irritating to the digestive tracts of farm animals than that of the rough awned varieties.

BARLEY FOR MALTING

Barley of the right type and quality finds a ready market for the manufacture of malt. O.A.C. 21, Mensury, Montcalm, Olli, and Hannchen are classed as suitable varieties for malting. Up to the present time O.A.C. 21 has been considered the best malting barley grown in Canada. During recent years in Ontario this variety has been outyielded by the newer smooth awned varieties. For this reason it is likely that on many farms Montcalm will replace O.A.C. 21 as a malting barley. In tests made to date this smooth awned variety produces malt of as high a quality as O.A.C. 21. Mensury, Olli, and Hannchen are not as well adapted to Ontario conditions as are the better smooth awned varieties, and farmers growing these varieties for malting would have to take into consideration their lower yielding capacity.

THE PLACE OF OATS AND BARLEY IN THE CROP ROTATION

Barley often follows a hoed or cultivated crop and precedes a hay crop. It is a good nurse crop with which to seed down grasses and clovers, because it is harvested early and because the foliage is not dense. If it is grown as a second grain crop in the rotation special attention should be given to maintaining soil fertility, as barley is not a profitable crop on soils where plant food material is not readily available. It may also be sown after a hay crop or pasture.

The place of oats in the rotation is similar to that of barley. Because it does not require as high fertility as barley, it is a better crop to use as a second grain crop if it is necessary to have one spring grain follow another on part of a farm. When sown as a second grain crop, which is usually a nurse crop, an early variety of oats gives best results. Early oats is probably a better nurse crop than most barley varieties, while late oats is not as good as barley.

SOILS FOR OATS AND BARLEY

Barley may be grown on a fairly wide range of soil types, but it does not yield as well as oats on the poorer soils. Both yield well on well drained, fertile clay loam. Barley requires more lime than the other small cereals, and will not grow as well on acid soils.

Oats and barley are likely to lodge badly on heavy soils if they are very fertile, or if there is an excess of nitrates.

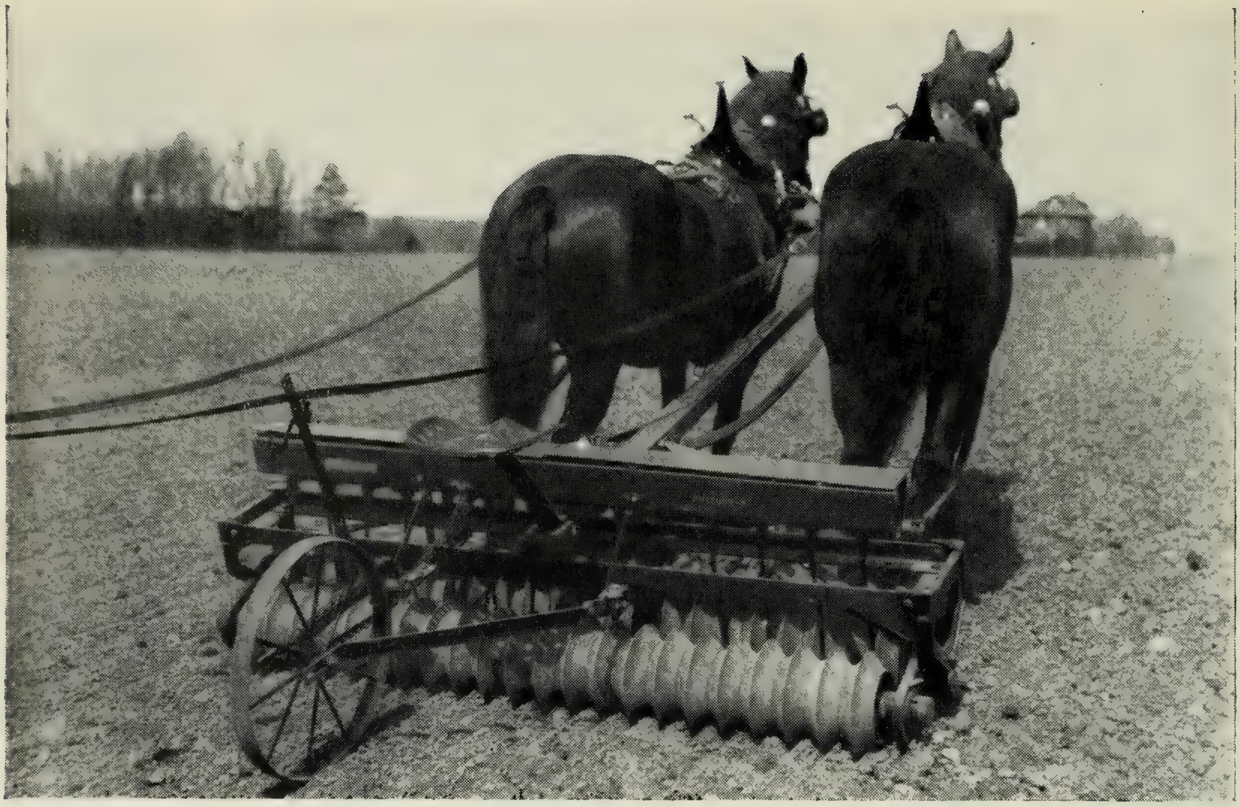
On poor soils or sandy soils the grain is of poor quality, and the straw is short.

FERTILIZING THE SOIL

When oats or barley follow a hoed crop there are usually unused plant food materials remaining from the barnyard manure or fertilizer applied to the previous crop. If barley is grown as a second grain crop it will be benefitted by a direct application of manure. When manure is the chief means of maintaining fertility, and when clover and alfalfa follow these grain crops in the rotation, it generally pays the grower to use some commercial fertilizer containing a high percentage of phosphate and potash. The kind and amount to use may be determined by having the soil tested. Commercial fertilizer is of special value in correcting soil deficiencies which may be revealed by tests. On acid soils barley will benefit more than oats by the application of lime. Information about soil testing and fertilizer requirements may be obtained by writing to the Soils Department, Ontario Agricultural College, Guelph; the Kemptville Agricultural School, Kemptville; the Western Ontario Experimental Farm, Ridgetown; or by consulting the Agricultural Representative for the county in which the farm is located.

CULTIVATION OF THE SOIL

Fall plowing usually gives better results than spring plowing on the heavier soils. When the soil is top worked after fall plowing to control weeds it may be ridged with a double mouldboard plow, if time and available labour permit. If the land is not level the ridges should cross the slopes, if possible. This helps control erosion caused by surface



The use of the Cultipacker prepares a fine seedbed for Grasses and Clovers sown with Oats and Barley.

drainage. Ridged land may be worked sooner in the spring, as it dries more quickly than level land. It may be levelled down in the spring with a cultivator driven lengthwise of the ridges, and then harrowed until a fine seed bed is made. The fineness of the seed bed is particularly important when grass and clover seed is sown with the grain crop. The land can be rolled to compact the soil and break lumps after seeding, but when a roller is used it should be followed by a light drag harrow. The use of a cultipacker instead of the roller and harrow gives good results, especially when seeding down to grass and clover.

PLOWING VERSUS OTHER MEANS OF CULTIVATION

If the nature of the soil or the method of cultivating the previous crop make plowing unnecessary the land may be prepared for sowing more cheaply and quickly by the use of the one-way disc, the disc harrow, or any implement which will work up a good seedbed. If the subsoil is open enough to permit good drainage and root growth all that is necessary is enough top working to kill weeds and provide a seedbed. Unnecessary working of the soil increases the cost of production and seldom increases the yield. It increases soil erosion on hilltops and hillsides, particularly in light soils.

Plowing will leave cleaner, more easily worked soil in sod, and where there is a large amount of refuse from the previous crop.

PREPARATION OF THE SEED

The treatment of barley seed with recommended dusts, or formalin, will control covered smut and some other diseases which are carried in the spore stage on the seed. Covered smut is not a serious disease of barley here, as it is seldom found in Ontario. Directions for seed treatment can be obtained by writing to the Department of Botany, Ontario Agricultural College, Guelph, or by consulting the county Agricultural Representative.

Loose smut of barley cannot be controlled by any chemical treatment. The hot water treatment is effective, but for this proper equipment is necessary, which is usually not available on the farm.

If the barley crop becomes badly affected by this disease it is best to get new seed from fields which were free of loose smut the previous year. Registered seed is recommended, as it is produced in fields which are inspected for diseases.

Loose smut and covered smut of oats can both be controlled by treating the seed with organic mercury dusts or with formalin.

Tests of oats and barley seed at the Ontario Agricultural College show that a good grade of seed produces a considerably larger crop than that grown from a poor grade of seed.

Large, plump seed may be obtained by the use of a fanning mill equipped with the proper screens for the crop, and run and fed at the right rate of speed. Different adjustments are required for different varieties of grain as there is a difference in kernel size. Weed seeds are removed at the same time.

Commercial seed cleaning plants do good work in cleaning out weed seeds and grading seed. Clean, well graded seed pays crop dividends.

TIME OF SEEDING

Experiments at Guelph have shown that the highest yields have been obtained when oats and barley were sown as early as soil and climatic conditions permit. Both crops were subject to greatly reduced yields if planting was long delayed. The grain yield of early oats was reduced less than that of late oats or barley by delayed seeding. Very early seedings sometimes result in frost damage to barley, and to a lesser extent to oats as well; but the chances of decreased yields due to late planting are much greater than the chances of injury from frost.

Winter barley should be seeded August 25th to September 15th, depending on the location in Ontario.

RATES OF SEEDING

The usual rate of seeding oats in Ontario is from two to three bushels per acre. A greater measured quantity of seed must be sown with large seeded varieties than with small seeded varieties to obtain the same number of plants. Hulless oats should be seeded at the rate of 75 pounds per acre.

When oats is used as a nurse crop for grasses and clovers the rate should be reduced to one and a-half bushels per acre. The yield of the nurse crop may be reduced somewhat, but a better stand of grasses and clovers will be obtained.

Barley of the O.A.C. 21 type should be sown at the rate of at least two bushels per acre, or one and a-half bushels per acre if grass and legume seeds are sown with the barley. Larger seeded varieties such as Barboff require one or two pecks more seed per acre. Barley sown at the rate of three bushels per acre fairly early in the season is an effective smother crop for many weeds commonly found in grain fields.

SEEDING METHODS

The proper depth for sowing either oats or barley is one to one and a-half inches in a well-prepared, moist seedbed. On soils which dry out easily two to two and a-half inches or even deeper is considered preferable. The seed may be sown with a broadcast seeder or a grain drill seeder. Drilling gives a better distribution of the seed and more uniform coverage.

HARVESTING

Cutting with the binder should be done when the grain is in the hard, dough stage. If left until dead ripe the loss of grain through head shattering will be increased. Barley dries better in long stooks than in round or capped stooks. Leave the crop in the stooks until the grain hardens, and the straw is dry enough to thresh easily. Then it may be stook threshed, or stored in barns or stacks until a threshing machine is available.

Combine harvesting of oats and barley greatly reduces the labour involved in the production of these grains. When the crop is harvested with a combine it should be left until the grain is well ripened and dry. After harvesting the grain the straw may be raked with a side delivery rake, and picked up by a hay loader or a pick-up baler.

THRESHING

Stook threshing should be done as soon as the grain is dry enough. The grain is ready for threshing as soon as the moisture content is reduced to not more than fourteen percent. The experienced grower knows by handling and seeing the grain when it is ready for threshing. If threshed when moist the awns are not removed closely from barley, and the grain may heat in the bin. Grain crops that have been stored in stacks or barns often thresh better than when they are stook threshed.

The cylinder speed for small grains is usually 1,200 revolutions per minute. The speed of the cylinder and the adjustment of the concaves should be such that the awns are removed from barley without shattering the kernels or splitting the hulls. Some varieties are more easily threshed than others and require different adjustments of the threshing machine. Oats usually thresh more easily than barley. Too close threshing often removes the hulls from thin hulled varieties of oats.

STORING THE GRAIN

Grain having a moisture content of fourteen percent or less may be stored in bins or sacks without danger of spoiling. If it is necessary to combine or stook thresh grain having a higher moisture content than the percent stated, the grain can be stored in shallow piles, and moved once or twice before it is put in deep bins.

OAT-BARLEY MIXTURES

The growing of mixed grain is a common practice in Ontario. The mixture recommended is equal amounts by volume of oats and barley and the mixture sown at two and one-half bushels per acre. Tests have proven that a mixture will give a larger yield per acre than either oats or barley seeded alone. Such mixtures should be grown for feed only since the mixture does not sell so well as either grain alone. Varieties of oats and barley that mature at the same time are essential to the success of the practice of growing mixed grain. Any combination in the following groups is recommended for Ontario:

Group I

Oats	Barley
Alaska	O.A.C. 21
Cartier	Barboff
Ajax	

Group II

Erban	Galore
Beaver	Byng
Beacon	Montcalm
	Velvet

Crossing Barley

Test plots of plant breeder strains, showing differences in straw strength.

BREEDING NEW VARIETIES

A great deal of progress has been made in the last twenty years in the development of new varieties of oats and barley. This has been accomplished by crossing strains which have desirable characteristics. Careful selection of the progeny of these hybrids has produced pure strains which are superior to the parents.

The objective of plant breeders is to develop high yielding strains which produce good quality grain. Such strains must have resistance to the principal diseases which attack the crop in this country. This is especially true of diseases which are not easily controlled by simple seed treatment.

In oats considerable success has been achieved in the development of high yielding strains which have a good degree of resistance to stem rust, crown rust, and smut. In barley the development of disease resistant varieties has lagged somewhat behind that of oats. However, most cereal breeding stations in Canada are working on this problem at the present time. Barley breeders have developed varieties which have the characteristics of smoothness of awn, high yield, good weight per bushel, and strong straw. Also, breeding work on barley is continuing to develop strains which have resistance to mildew, stem rust, leaf rust, and smut.

The testing of new strains of barley for malting quality is carried out each year since the development of a high yielding barley which is also a good malting barley would increase the value of the barley crop to the general farmer.

Some new varieties are adapted only to certain local areas. For this reason farmers are strongly advised to check with the nearest Experi-

The time required to produce new varieties is shortened by making crosses and growing early generations in the greenhouse during the winter.

mental Station, or Agricultural Representative, to determine the suitability of new varieties to localities in Ontario. This is especially true if the variety under consideration was produced in another province or country.

VARIETIES OF OATS

Early Maturing Varieties

Alaska was introduced into Ontario in 1900 from the United States. It has long, strong straw and the grain is large and thin-hulled. This variety tillers rather sparsely and therefore should be seeded at a slightly higher rate than most other varieties. It carries no resistance to crown rust, stem rust, or smut. The grain is of very high quality when a good crop is obtained.

Cartier was produced at Macdonald College, Quebec, from a cross between Alaska and Early Triumph. It is quite similar in appearance to Alaska. When a good crop is obtained the grain is of high quality. This variety is susceptible to crown rust, stem rust, and smut.

Vicland is a variety imported from the United States in 1940. It has very short straw and the kernels are small and yellow in colour. This variety has considerable resistance to crown rust, stem rust, and smut. Tests in Ontario have shown that this variety is outyielded by most of the newer varieties mentioned in this bulletin. Vicland is very susceptible to Helminthosporium victoriae, a new root rot disease which appears to be increasing in Ontario.

Ajax was developed at the Dominion Laboratory of Cereal Breeding, Winnipeg, from a cross between Victory and Hajira. It has considerable resistance to stem rust. Tests in Ontario have shown this variety to be well adapted to this province since it has consistently been one of the highest yielders since it was introduced. The straw is long and fairly strong. The kernels are somewhat smaller than those of the older varieties.

Clinton is a recent introduction from the United States. The straw is short and fairly strong. The kernels are smaller than average and yellow in colour. This variety is resistant to crown rust, stem rust, and smut, but it has not been sufficiently tested in Ontario to make any recommendations regarding its adaptability.

Medium Maturing Varieties

Erban was produced at the Ontario Agricultural College from a cross between Early Ripe and Banner. It has resistance to some races of crown rust and is quite resistant to smut. The kernels are large with a medium hull. This variety will do well in most of Ontario.

Beaver Oats was produced at the Central Experimental Farm, Ottawa, from a cross between Vanguard and Erban. The straw is medium in length and fairly strong. The kernels are large and with a medium hull. This variety has considerable resistance to stem rust and crown rust, and will do well in most of Ontario.

Beacon Oats was produced at the Central Experimental Farm, Ottawa, from a multiple cross involving Gold Rain, Alaska, Legacy, Victoria, RL 453, and Vanguard. The straw is shorter than average and is very resistant to lodging. The kernels are of good size with a medium thick hull. This variety is resistant to most strains of stem rust, and all strains of leaf rust, but is susceptible to Helminthosporium victoriae, a new root rot disease.

Garry Oats was produced at the Dominion Laboratory of Cereal Breeding, Winnipeg, from a multiple cross involving Victory, Victoria, Hajira, Banner, and RL 524. The straw is of medium length and the grain rather short and plump. This variety is resistant to all known races of stem rust, as well as to the races of crown rust and loose and covered smut that are found in Canada. However, like Vicland and Beacon, this variety is susceptible to Helminthosporium victoriae. Garry has not been tested sufficiently in Ontario at the present time to make any recommendations regarding its adaptability to conditions in this province.

Vanguard was produced at the Dominion Laboratory of Cereal Breeding, Winnipeg, from a cross between Hajira and Banner. It was one of the earlier stem rust resistant varieties and it yielded fairly well in both Eastern and Western Canada. In Ontario it is being replaced by the newer rust resisting varieties. Vanguard has straw of medium length and of fair strength. The kernels are smaller than average with a medium thick hull.

Late Maturing Varieties

Victory was introduced to Canada from Sweden. It was a popular variety but has been largely replaced in Ontario by the newer rust resistant varieties. The straw is medium in length and fairly strong except when badly affected by stem rust. When a good crop is obtained the kernels are large and very plump. This has made Victory a good exhibition oat. This variety is not recommended for general use in Ontario because of its lateness and susceptibility to crown and stem rust.

Banner was introduced into Canada from the United States by the Ontario Agricultural College in 1890. It has been largely replaced by earlier rust resistant varieties. The straw is medium in length and of fair strength, and the grain is of good size. This variety is not recommended for general use in Ontario since tests have shown that it is outyielded by a considerable margin by the earlier rust resistant varieties.

Roxton was produced at MacDonald College. It has long straw and large leaves, but it stands up well. This variety carries some resistance to crown rust and stem rust. Roxton has not yielded so well at the College as some of the earlier varieties but where a late maturing oat is desired this variety is recommended.

Hulless Oats

Brighton is medium maturing with long straw and large kernels. It is resistant to smut, but susceptible to both stem and crown rust.

Laurel is medium maturing with long straw and medium sized kernels. It is not resistant to the rusts or smuts. Neither Laurel or Brighton have yielded as well as the better hulled varieties in tests in Ontario, and are therefore only grown where a low fibre feed is required.

Winter Oats

No variety of winter oats has yet been produced which will withstand the winter conditions in Ontario.

VARIETIES OF BARLEY

Rough Awned, Six-Rowed, White Grained Varieties

O.A.C. No. 21 is a medium early variety. The aleurone layer beneath the hull is a bluish gray unless discoloured by weathering. The straw is strong and the yield of grain is good. It should be harvested before it is dead ripe, as the heads tend to break over badly at maturity. This variety is well adapted to sowing in mixtures with early oats for livestock feed, as it matures at about the same time as Alaska and Cartier Oats, which is usually about ninety days from seeding when the seed is sown early. O.A.C. No. 21 was developed at the Ontario Agricultural College by pure line selection from a barley of the Manchurian type imported from Eastern Asia.

Mensury (Ottawa 60) is similar in appearance and performance to O.A.C. No. 21. This variety was developed at the Central Experimental Farm, Ottawa, from a barley of the Manchurian type.

Olli is a very early maturing variety imported from Finland. It is not important in Ontario, but is grown in the prairie provinces where a very early variety is required. In Ontario field tests Olli has not yielded as well as some of the medium early varieties.

Smooth Awned, Six-Rowed, White Grained Varieties

Nobarb is a mid-season variety which matures in about ninety-five days from seeding at Guelph. The straw is fairly strong, and the grain is a little larger and plumper than that of O.A.C. No. 21. The yields of both grain and straw have been greater than those of O.A.C. No. 21 in most of the tests at the Ontario Agricultural College, and in Western Ontario. Nobarb is a pure line selection from the progeny of a cross of O.A.C. No. 21 and Lion made in 1921 at the College.

Barboff is a more recent selection of the same breeding as Nobarb. It is somewhat similar in type to Nobarb, but has shorter, stronger straw; larger, plumper grain; and a little earlier maturity. It has the greatest bushel weight of any variety yet produced for distribution by the College, and is a good variety to grow for livestock feed. It has very strong straw, and is one of the best varieties for combine harvesting.

Galore is a mid-season variety, maturing three or four days later than O.A.C. No. 21. The bushel weight of grain is similar to that of a good sample of the latter variety. Galore is one of the highest yielders of grain ever grown at the College. The straw is somewhat longer than that of Barboff, and is shorter than that of O.A.C. No. 21 or Nobarb. Galore was selected from the progeny of a cross of O.A.C. No. 21 and Lion which was crossed back to O.A.C. No. 21. It may be distinguished from the other O.A.C. varieties by the fact that it has long rachilla hairs, while those of the others are short.

Velvet is a high-yielding variety introduced from Minnesota. It was one of the first smooth awned varieties grown in Ontario, but is now being replaced by newer varieties. It matures two or three days later than O.A.C. No. 21.

Newal is a variety bred at the University of Alberta. Its maturity is about the same as that of O.A.C. No. 21. It yields fairly well in Ontario, but has not yielded as well in tests here as Galore, Barboff, and Velvet. It is quite susceptible to smut.

Montcalm is a variety originated at Macdonald College, Quebec. This variety matures about four or five days later than O.A.C. No. 21. It is increasing rapidly in Ontario, as it is a good yielder of high quality grain, and is the only smooth awned variety distributed in Canada up to the present time which has good malting quality.

Byng is a semi-smooth awned variety bred at Macdonald College, Quebec. There are barbs from the tips of the awns about halfway to the kernels. This variety is one of the heaviest yielders of grain, but is weak strawed and is not recommended for soils high in fertility. It matures two or three days later than O.A.C. No. 21.

Vantage is a new variety introduced by the Dominion Experimental Farm, Brandon, Manitoba. It is resistant to stem rust. It has not been sufficiently tested in Ontario to make any statement as to its suitability to conditions in this province.

Rough Awned, Two-Rowed, White Grained Varieties

Hannchen is a nodding headed variety which was imported from Sweden. It is one of the best yielders of the two-rowed varieties, but it often lodges badly, not having as strong straw as the better six-rowed

Field tests of new plant breeder strains.

varieties. It is about a week later than O.A.C. No. 21. The weight per bushel of grain is usually a little above the standard.

Stephan is a nodding headed variety imported from Europe. In tests at the College this variety has not produced as good yields of grain as Hannchen, and in regional tests throughout western Ontario it has been inferior to the best six-rowed varieties. It has about the same straw strength and weight per bushel as Hannchen. Stephan is resistant to barley mildew, which is a common disease in this region, often causing a reduction in the weight per bushel of susceptible varieties.

Smooth Awned, Two-Rowed, White Grained Varieties

Sanalta is a strong strawed variety maturing about a week later than O.A.C. No. 21. It is being grown in a few isolated districts in the province, but in general does not yield as well as the better six-rowed varieties.

Winter Barley

No variety of winter barley tested to date has proven to be as hardy as winter wheat. For that reason winter barley cannot be depended upon by the livestock feeder to produce a supply of feed grain year after year in most of Ontario. Winter barley will give heavy yields of grain where it survives the winter.

Tennessee Winter is a six-rowed, white grained, and rough awned variety. Both the grain and the standing crop somewhat resemble O.A.C. No. 21 in appearance. The straw is weak, and the crop often lodges on soils high in fertility.

Wong is a variety of winter barley recently introduced from Cornell University, New York. It is an intermedium type having awns on the main rows only. The awns are short and rough. This variety is suitable for combine harvesting. Excellent yields of grain have been obtained in yield tests at the Ontario Agricultural College. Since its introduction into Ontario it has not been subjected to a season when winter killing was severe, and so no definite statement can be made at this time about its winter hardiness. Up to the present its winter survival has been about the same as that of Tennessee Winter Barley.

NOTE: *Photographs through the courtesy of the Department of Public Relations, Ontario Agricultural College.*

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EMERGENCY HAY AND PASTURE CROPS FOR ONTARIO

By J. R. WEIR and J. LAUGHLAND
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RAPE AND KALE MAKE GOOD FALL PASTURE

ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 455 FEBRUARY, 1948

EMERGENCY HAY AND PASTURE CROPS FOR ONTARIO

by

J. R. WEIR and J. LAUGHLAND

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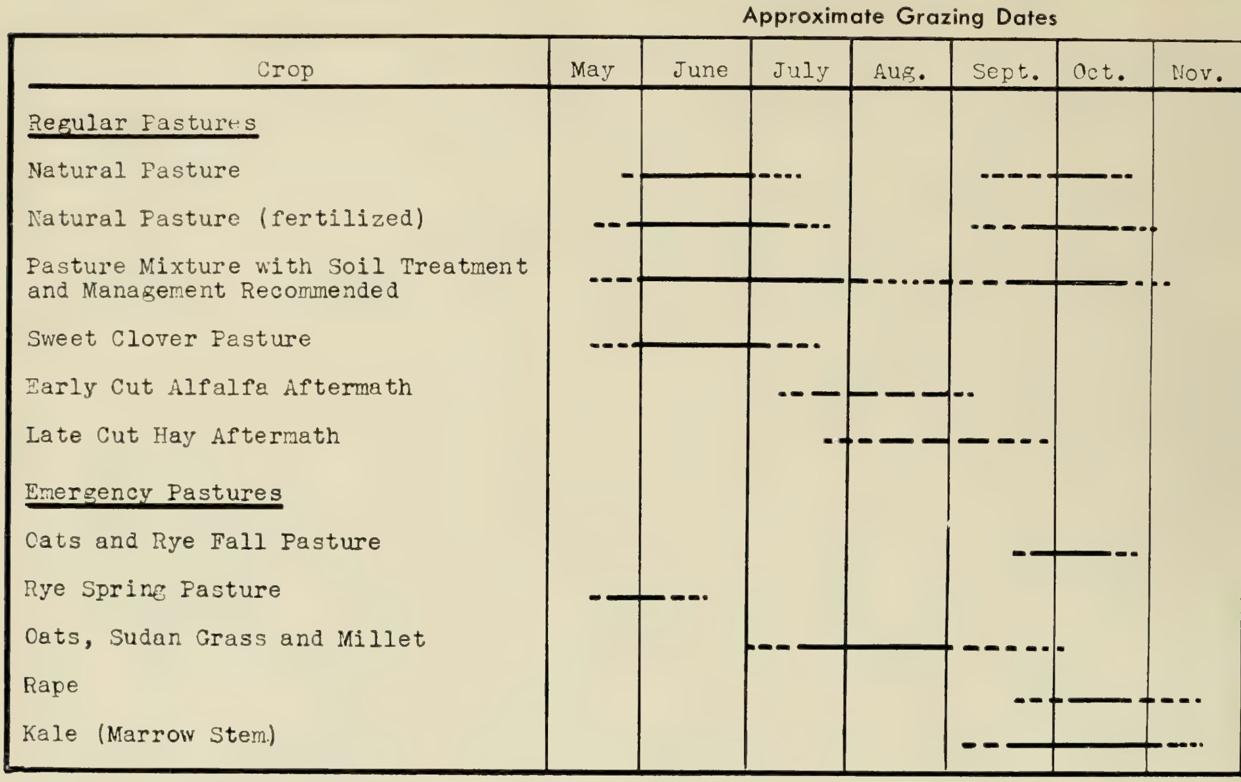
Hay and pasture crops in Ontario occupy nearly one-half of the cleared land and furnish the most economical source of feed for livestock. Data could be given to prove that a ton of digestible nutrients can be produced more economically from good pasture than from any other farm crop, but the farmer does not require figures to tell him that the milk flow from his dairy herd will increase when the grass is good and go down when it is poor.

As a general rule the soil and climate of Ontario are well suited to the production of grasses and legumes. Considerable attention is being paid to the improvement of long-term pastures. Better balanced mixtures are being used for hay and pasture in the regular rotations. It is from these sources that most of the hay and pasture should come, but in spite of every precaution this main forage programme must be strengthened by supplementary crops. Failure of new seeding to become established and the winter killing of legumes are conditions that may occur in unfavourable seasons and will have to be remedied. Unless action is taken when there is an anticipated shortage of hay and pasture there is likely to be a reduction in the number of livestock kept, and the whole production programme becomes disorganized. Such a condition can often be prevented by seeding emergency crops which require only a short time to come into production.

Under normal conditions, the growing season for grasses and legumes in Ontario has three weak periods. These are the low temperatures of early spring; the hot, dry period in July and August; and again, the cool weather of late fall. These unfavourable conditions do not occur to the same extent every year; but when they are present, growth is retarded, hay yields are reduced, and the carrying capacity of pastures lowered.

PROVIDING A FULL SEASON'S PASTURE FOR MIXED AND DAIRY FARMS



Emergency Hay and Pasture Crops Supplement the Periods of Low Production in the Regular Hay and Pasture Programme.

The above figure shows the productive periods through the growing season of our principal pasture crops. The solid lines indicate the period of full productivity, while the broken lines, the periods of partial productivity. It is the purpose of emergency pasture and hay crops to fill in the gaps, to provide pasture throughout the entire growing season, and to ensure enough hay for winter. These crops may be best discussed according to the period for which they are required:

1. Emergency Pasture for Early Spring
2. Emergency Hay and Pasture for Midsummer
3. Emergency Pasture for Fall.

* * *

Fall Rye sown between August 1st and 15th will furnish Good Pasture for Fall and Spring.

EMERGENCY PASTURE FOR EARLY SPRING

Fall Rye

Fall Rye at two bushels per acre sown between August 1st and 15th will furnish good pasture for *fall* and *spring.* This provides a good early spring growth and allows the regular pasture to get well started before it has to be used. If the rye is not grazed too severely it can be left for grain, or it can be ploughed down and the land seeded to late sown crops such as sorghum, millet, or mixtures for pasture. In Eastern Ontario the general practice in ploughing down of rye in the spring is to follow with either silage corn or potatoes.

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EMERGENCY HAY AND PASTURE FOR MIDSUMMER

Oats and Peas

A mixture of oats and peas is one of the best emergency hay crops that can be grown if it is sown early. Under normal conditions it will produce more than two tons per acre of high quality hay. Now that rust resistant varieties of oats are available, the quality of hay will be even higher in years when rusts are prevalent. Small seeded peas, such as O.A.C. No. 181 and Golden Vine which produce pods fairly evenly spaced along the vines, are suitable for this mixture. *The best rate of seeding is two bushels of oats and one bushel of peas per acre.* Oats may be sown alone and cut green for hay, but the crop can be cured with less difficulty if it contains a sprinkling of peas. *The mixture should be sown as early in May as possible,* and it will be ready to cut when the oats are well filled and the pea pods are half developed. It is cured and handled like any other hay crop. If a field of this mixture is put in and it is found by July that due to favourable growing conditions there will be enough hay without it, the crop can be allowed to ripen for grain.

Oats and Sweet Clover

This is a satisfactory emergency pasture mixture for Ontario. *It should be sown in May, using two-and-a-half bushels of oats, and fifteen to twenty pounds of scarified sweet clover per acre.* Stock may be turned on it in about six weeks. It should be grazed sufficiently to keep the oats from coming into head. The sweet clover comes along for later pasture. If the stand is good it can be left for pasture or hay the following year. The oats in this mixture can be allowed to ripen for grain if the pasture is not required.

Sudan Grass

Sudan Grass is one of our heaviest producing emergency pasture crops for late summer and fall, and is characterized by good palatability, high nutritional value, and ability to withstand dry weather.

This crop is adapted to a wide variety of soils in Old Ontario, provided they are warm, dry, well-drained, and the growing season is reasonably warm. It is a heavy producing crop, and requires an abundant supply of readily available soil fertility.

The average of seven years' results at the Ontario Agricultural College shows yields of Sudan Grass of over fourteen and one-third tons of green crop and three tons of dry crop per acre. This exceeded Hungarian Millet by four tons of green crop and a half ton of dry crop per acre. The above figures are of crops cut when in the pasture stage of growth.

Sudan Grass should be sown in the latter part of May or early June on a thoroughly prepared seedbed, with ample moisture. This is best

Oats and Sweet Clover make a good Midsummer Pasture.

guaranteed by sowing on fall-ploughed land. In Eastern Ontario with Sudan Grass or in mixtures the most satisfactory results are obtained when the ground has been well warmed up about the middle of June. *The rate of seeding is thirty pounds per acre, sown shallow through the tubes of the drill.*

For best grazing results, permit the crop to attain a height of eighteen to twenty inches, and at no time allow it to be pastured off too closely.

Where earlier pasture is required, *the Sudan Grass may be sown in a mixture composed of two to two-and-a-half bushels of oats and twenty pounds of Sudan Grass* per acre, sown as early as possible in the spring. The oats are ready for pasture when they attain a height of twelve to fifteen inches, and should be pastured sufficiently heavy to prevent them from coming into head. However, when this mixture is sown, the yield of pasture is less than when Sudan Grass is sown alone.

If the season is such that the Sudan Grass is not required for pasture, it yields an abundant crop of palatable hay which should be cut when in the early heading stage, and made in the usual approved methods for haymaking.

In the United States, there have been some cases of stock poisoning from Sudan Grass, but there are no authentic reports of any trouble of this kind in Ontario. However, it is well to *avoid pasturing very young or stunted Sudan Grass, or a stand that has been severely frozen.*

Millet

This crop may be grown for either hay or pasture, but it is not as suitable for pasture as some of the other crops mentioned in this bulletin. *It should be sown during the first half of June* on well-prepared soil *at the rate of twenty to thirty pounds of seed per acre,* depending on variety and size of seed. Some of the varieties grown for fodder are Siberian, Hungarian, Empire and Common. The crop can be pastured when it is one foot high, or cut for hay when it comes into head. Some varieties will be ready for hay in about eight weeks from time of seeding. Millets are not particularly high in feeding value, but they will produce a large amount of roughage which can be used to advantage in conjunction with alfalfa or other legumes.

Soybeans

Tall growing varieties of soybeans such as A.K., Lincoln and Manchu will produce very good annual hay if sown early. For later seeding O.A.C. No. 211 and Mandarin may be used. The usual *rate of seeding is one and three-quarter bushels per acre, drilled solid.* The cost of seed in growing soybeans for hay is a considerable item, but an average crop will yield about two tons of cured hay per acre, and if well cured the quality is nearly equal to alfalfa. *The hay is usually cut about the end of August* when the beans are half-grown in the pods and before the lower leaves fall off. It is cured the same way as mixed hay.

Soybeans are not very suitable for pasture. They do not stand tramping and make slow recovery when eaten off.

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EMERGENCY PASTURE FOR FALL

Corn

It is good practice to sow some extra silage corn in anticipation of a pasture shortage in September. This surplus can be cut and fed green to keep up the milk flow, or if the pasture remains plentiful the extra corn can be put in the silo or if no silo is available it can be stooked and dried for early winter feeding. In areas where husking corn is grown, part of the crop can be used for fodder when the necessity arises.

It is Good Practice to Sow some Extra Silage Corn for Green Feed in September.

Sorghum

Sorghum or Early Amber Sugar Cane grows somewhat like corn but instead of having ears the seed is produced at the top of the plants. This crop will not yield as much as corn but it can be sown later, and will stand dry weather better. Some farmers sow a patch of it near the barn to cut for green feed if the pasture gets short around the first of September. The rate of seeding is six to ten pounds per acre in rows thirty inches apart. In addition to providing fodder for fall use *a mixture of oats, one-and-one-half bushels, and Sorghum, thirty pounds per acre, sown about the end of May, will furnish good summer pasture.*

Oats and Fall Rye

Oats at one bushel per acre and Fall Rye at one-and-a-half bushels per acre make an excellent fall and early spring pasture. This mixture should be seeded sometime during the first two weeks in August. The oats will supply the early fall pasture while the rye furnishes the late fall and early spring growth.

Rape and Kale

Rape and Kale make good fall pasture. They are not readily injured by frost, and will furnish pasture for cattle and sheep later than most other crops if the snow keeps off. In Southwestern Ontario Rape does not do so well but Kale is an excellent crop. These crops can be sown in drills twenty-four to thirty inches apart, using one-and-a-half to two pounds of seed per acre, or they may be sown broadcast, when four or five pounds of seed will be required. Seed should be sown six to eight weeks before the crop is required for pasture. There is less waste from tramping if the crop is in drills. Dwarf Essex Rape and Marrowstem Kale are good varieties.

The best results from emergency hay and pasture crops can be obtained only when they are sown at the most suitable time. Usually by the middle of May, it is possible to tell how the meadows have come through the winter, and that is the time to decide what emergency hay and pasture crops to use.

N.B.—Photographs through the courtesy of the Department of Public Relations, Ontario Agricultural College.

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DWARF APPLE AND PEAR TREES

IN THE HOME GARDEN

By W. H. UPSHALL

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SECOR APPLE ON MALLING IX ROOTSTOCK IN THE THIRD SEASON AFTER PLANTING

ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 456 JUNE, 1948

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DWARF APPLE AND PEAR TREES

IN THE HOME GARDEN

Ardent gardeners, those who like working in the soil and who enjoy seeing plants grow, often have a yearning for fruit trees. However, limited garden space usually makes it impossible to establish even a small orchard on the property—and it may be well that it is so. While the trees are young and small they do not present many cultural difficulties but when they get to mature size many problems arise, the most pressing of all that of adequate spraying. The owner does not, as a rule, possess a power sprayer of his own, and is therefore dependent on custom spraying. Under these conditions, it may not be possible to have the best timing for maximum control of insects and diseases. Often too, the proximity of buildings makes it difficult to get uniform coverage throughout the tree.

This is the place where dwarf fruit trees seem to fit into the owner's picture of the "complete" garden. If pruning, thinning, and picking could be done wholly or largely while standing on the ground, and if a small hand sprayer or duster would take care of the spray problem, there would be more chance of making a success of the home-garden "orchard". This can be done with the dwarf fruit trees.

Trees on the rootstocks considered in this publication come into bearing from one to four years earlier than standard trees, the spread depending on variety. In some cases a few fruits may be borne in the second year in the garden but the owner should not count on such early production. By the sixth to ninth year each of the apple trees should be capable of bearing a bushel of fruit and for at least a dozen more years there should be a general upward trend in yield. As a rule, dwarf pear trees are slower than dwarf apple trees in coming into bearing, and less productive.

SITE AND SOIL

In the average home garden there is little, if any, choice of soil and site. It is fortunate therefore that dwarf apple and pear trees do well on a wide range of soils. As a rule the only soil to be avoided is the water-logged one. Be they dwarfs or standards, fruit trees do poorly, may not even survive, under "wet feet" conditions. Sometimes tile drainage may correct the condition and occasionally deep open ditches leading to a good outlet are sufficient insurance against poor conditions for root growth. Roots of dwarf trees are usually less winter hardy than those of standard trees. A grass or plant-refuse mulch, plus snow, over the root area will give protection.

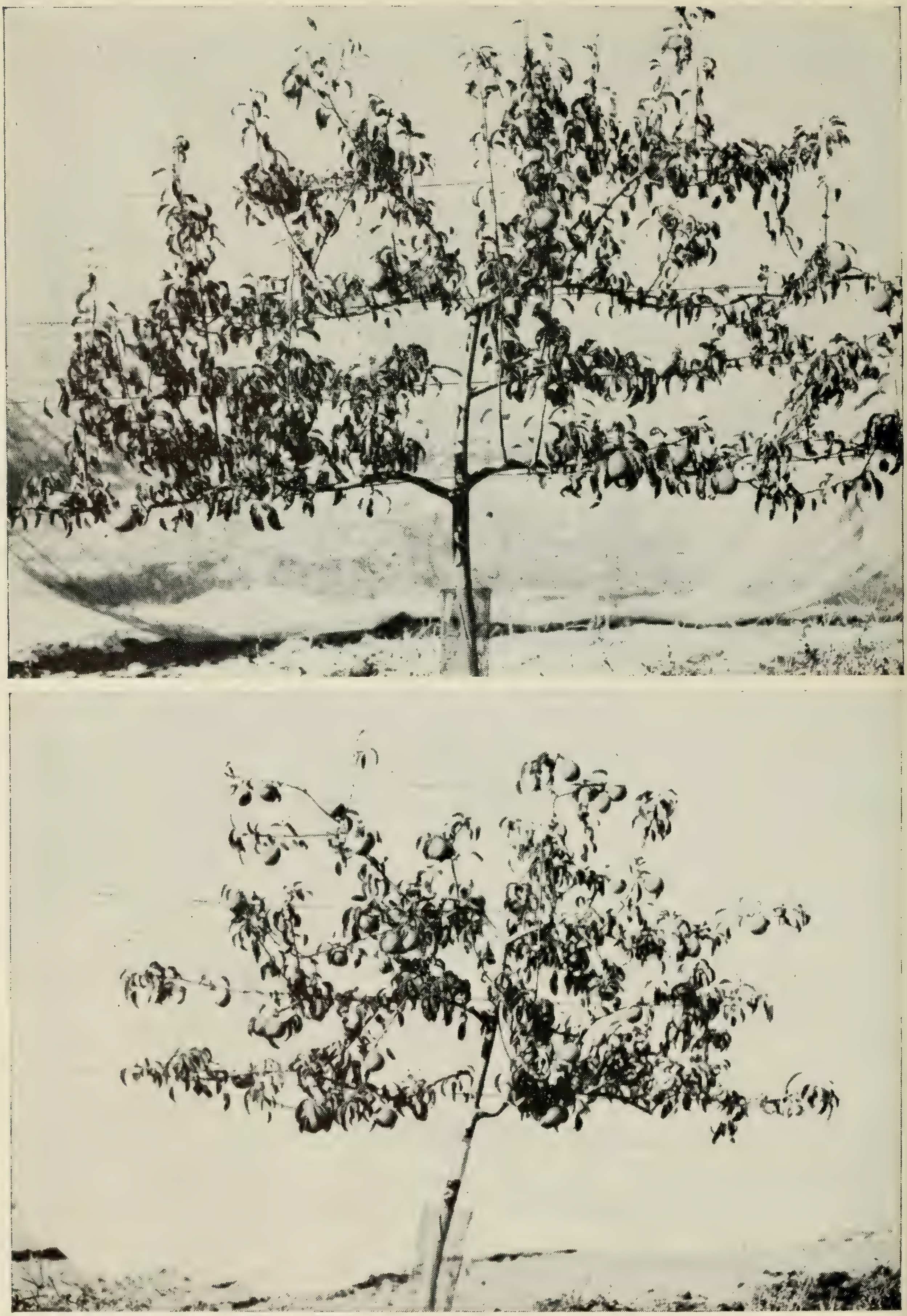

FIG. 1. Anjou pear on Quince A (top) and Quince C (bottom) in the tenth season after planting.

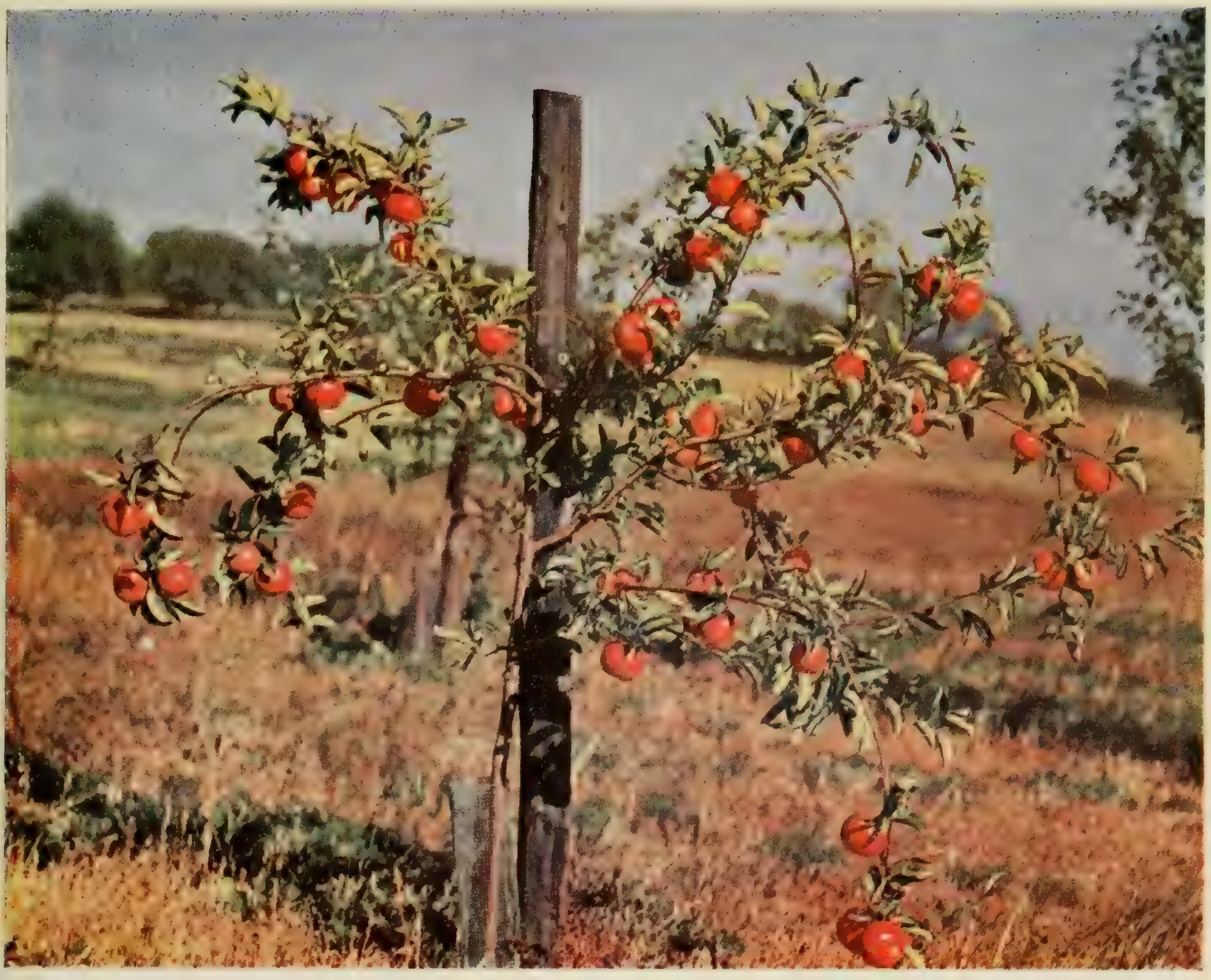

FIG. 2. Wagener on Malling IX rootstock in the fifth season after planting. High fruit colour is common on trees growing on this rootstock.

DWARFING ROOTSTOCKS

The most practical way to get dwarf fruit trees is by propagation on suitable rootstocks. For apple, the only one worth consideration at the present time is Malling IX, the original French name being Jaune de Metz. It gives a much smaller tree than any other apple rootstock now available commercially. For pears, Quince A (Angers) is the commonly used dwarfing rootstock. At Vineland, Quince C gives a tree about half the size of those on Quince A but slightly more productive for its size. When it becomes available commercially it would perhaps be better for those varieties which grow too vigorously on Quince A (example, Vermont Beauty) or where limited space is available for a tree. Unfortunately some pear varieties, notably Bartlett and Clapp Favorite, are partially incompatible with the quince, subject to breakage at the union or a short life span. These varieties would be more certain if topworked on a variety which agrees well with the quince, such as Hardy, Old Home, Anjou, or Duchess.

For the stone fruits there are no generally satisfactory dwarfing rootstocks in a class with Malling IX for the apple and Quinces A and

C for the pear. Interested persons should keep in touch with developments at Experiment Stations in this field of research.

NURSERY STOCK

In response to the demand, most nurseries are growing several apple varieties on Malling IX and several pear varieties on Quince A. Quince C has not yet come into general use. The customer is well advised to specify the rootstock desired as well as the top variety. It is not sufficient to order under the designation "dwarf". The order should specify McIntosh on Malling IX, Cox Orange on Malling IX, Anjou on Quince A, Giffard on Quince A, etc., otherwise a less desirable rootstock may be obtained. The point is the term "dwarf" in reference to rootstocks may refer to many different rootstocks—some desirable, some otherwise.

Trees should be ordered by age and grade. For the average purchaser two and three-year trees are likely to be more satisfactory than one-year trees. The larger trees have more reserves which permit a better start the first year in the garden. The diameter ranges for the various grades of dwarf apple and pear nursery trees, measured two inches above the bud union, are as follows:

No. 1 Grade — ⅝ inch and up
No. 2 Grade — ½ to ⅝ inch
No. 3 Grade — ⅜ to ½ inch

There are no height requirements, therefore customers should specify if a particular height of tree is desired.

VARIETIES

In the choice of varieties to plant, many amateur fruit growers will be guided by their own personal taste preferences. For those who are undecided, the following lists of varieties given in order of maturity may be considered. Outside of the commercial apple districts only the hardy varieties (marked with an asterisk) should be used.

APPLES

***Yellow Transparent.** Bears very early. For good size and quality, fruit thinning will often be required.

***Melba.** Very high in quality. It ripens over a long period in the latter part of August, making several pickings necessary. Usually it bears only every second year (for correction of this habit see under Thinning).

*__Joyce.__ Not well known but is the best quality apple for its season (early September). Like Melba it tends to have "off" years.

*__Milton.__ A good quality apple which ripens over a long season giving many pickings, an advantage in the home garden. An annual bearer.

*__McIntosh.__ Outstanding in its high yields of high quality fruit. Both leaves and fruit are very susceptible to scab and should be kept covered with spray or dust.

Cox Orange. Generally considered in England as the peak of quality. Does well on Malling IX at Vineland.

Delicious. A semi-sweet apple which, for the best quality, should be planted only in the southern sections of Ontario. There are many high colour sports of this variety, Richared and Turner Red being two of the best.

Wagener. Makes a very small tree on Malling IX but the fruit is large and high in colour. Standard trees are susceptible to fire-blight but this does not necessarily rule out this variety as a dwarf tree.

Jonathan. A small, highly coloured apple which must be picked at the optimum time, i.e., when the green ground colour has just changed to a greenish-yellow colour. Picked too soon it shrivels in storage and the flesh is tough. Left on the tree too long it breaks down internally in storage.

Secor. On Malling IX Secor has been outstanding in yield and regularity of bearing at Vineland. The apple is high in quality and keeps well in storage.

Golden Delicious. Suitable only for the extreme southern districts of Ontario. An early bearer but requires thinning in some years if size and quality are to be attained.

Spy. Both Northern Spy and its red bud-sports grow very vigorously on Malling IX, almost too vigorously for trellis culture. However, in spite of rank growth, these trees come into bearing several years before standard trees.

PEARS

As a class, pear trees are not as winter hardy as apple trees. Outside of the commercial pear districts Clapp Favorite and Flemish Beauty would be the safest varieties to use. Those varieties marked with a dagger do not agree well with the quince and should be topworked on an intermediate stock which agrees with the quince, as Hardy, Old Home, Anjou, or Duchess. These are called double-worked trees. Though not now available in Ontario nurseries there is no good reason why they should not be produced, and indeed it is very unlikely that an order placed a year in advance of planting would be ignored. The customer must expect to pay more for these special trees but they are almost certain to give better satisfaction. Worked direct on the quince their life may be very short.

Giffard. For an early pear (mid-August) it has fair size and quality. Thinning would help when the set of fruit is heavy.

†**Clapp Favorite.** An attractive pear of good quality. It must be picked long before it ripens on the tree else it will go "mushy" around the core before the outer flesh is at the best eating stage.

†**Bartlett.** The standard of quality in commercial pear orchards both for fresh fruit and for canning.

Flemish Beauty. High in quality but very susceptible to scab for which extra sprays or dusts will be required.

Conference. A partly russeted pear which does best on light soils.

†**Seckel.** A small, sweet pear which will often require thinning. It keeps well in storage.

Anjou. A late fall and winter pear which keeps in storage better than any other common variety.

†**Bosc.** A large, sweet, high quality pear with partly or wholly russeted skin. In the nursery it grows very weakly on the quince. A better tree would result from topworking on one of the above intermediates.

Sheldon. A russet pear of high quality but inclined to be shy in bearing.

Apple and pear varieties are largely self-unfruitful. This means that poor crops will be obtained from isolated trees. There should be a tree of another variety of the **same** kind of fruit beside it, or at least within 100 feet of it. If blossoming times of the varieties overlap sufficiently, bees and other insects will carry pollen from one to the other thus ensuring a satisfactory set of fruit. If the home owner has room for only one tree of a kind he can have two or more varieties on the one trunk by a special order to a nursery or by grafting one or more limbs of the established tree to other varieties. Under Ontario conditions, all of the apple varieties and all of the pear varieties listed above are effective pollinators for one another.

TIME OF PLANTING

In south-western Ontario fall planting of two-year and older apple and pear trees seems to be quite satisfactory if done between November 10 and 20. Earlier, the trees may not be sufficiently well-matured before digging to stand low winter temperatures, and later, the weather may be unsuitable, or the soil too wet. Spring planting should be done early, preferably as soon as the soil is fit to work. A delay in planting at this time is bound to result in a reduction of growth in the first year and perhaps even a delay in time of coming into bearing. The purchaser should protect himself against late delivery from the nursery by ordering subject to delivery at what might be the earliest planting time in that area. If the trees arrive before it is possible to plant them, a trench should be dug in the soil in which the trees may be placed in an upright position. Then soil should be shovelled around the roots and tramped so that the whole root system is protected against drying.

SUPPORTS

Unfortunately trees on the currently recommended dwarfing rootstocks for home-garden use do not stand up well without support. With Malling IX for apple it is usually a breaking of the main roots; with quince for the pear, it is more often a breakage at the union. Either result is undesirable in that it means the complete loss of the tree, or a considerable set-back to it. The support, or supports, should be in place **before** the trees are planted. If put in afterwards there is almost sure to be some injury to roots or tops.

There are two main methods of support—(1) by individual post, (2) by trellis. In the first method a fence or grape post treated with a wood preservative, should be sunk about three feet. The tree should be planted on the side of the post from which the prevailing winds come and should be tied to the post in two or three places. The weakness of this method lies in the certainty of the post breaking over after a number of years and taking the tree with it. To guard against this loss the post should be replaced at least every 20 years.

By the second method, support is given to several trees in a row by means of a fence or trellis. Again, posts treated with a wood preservative should be used. They should be spaced about 30 feet apart in the row and the end posts should be anchored in some way to keep them upright. Along the posts four No. 9 galvanized wires should be strung at approximate heights of 2, 3, 4, and 5 feet from the ground or a woven

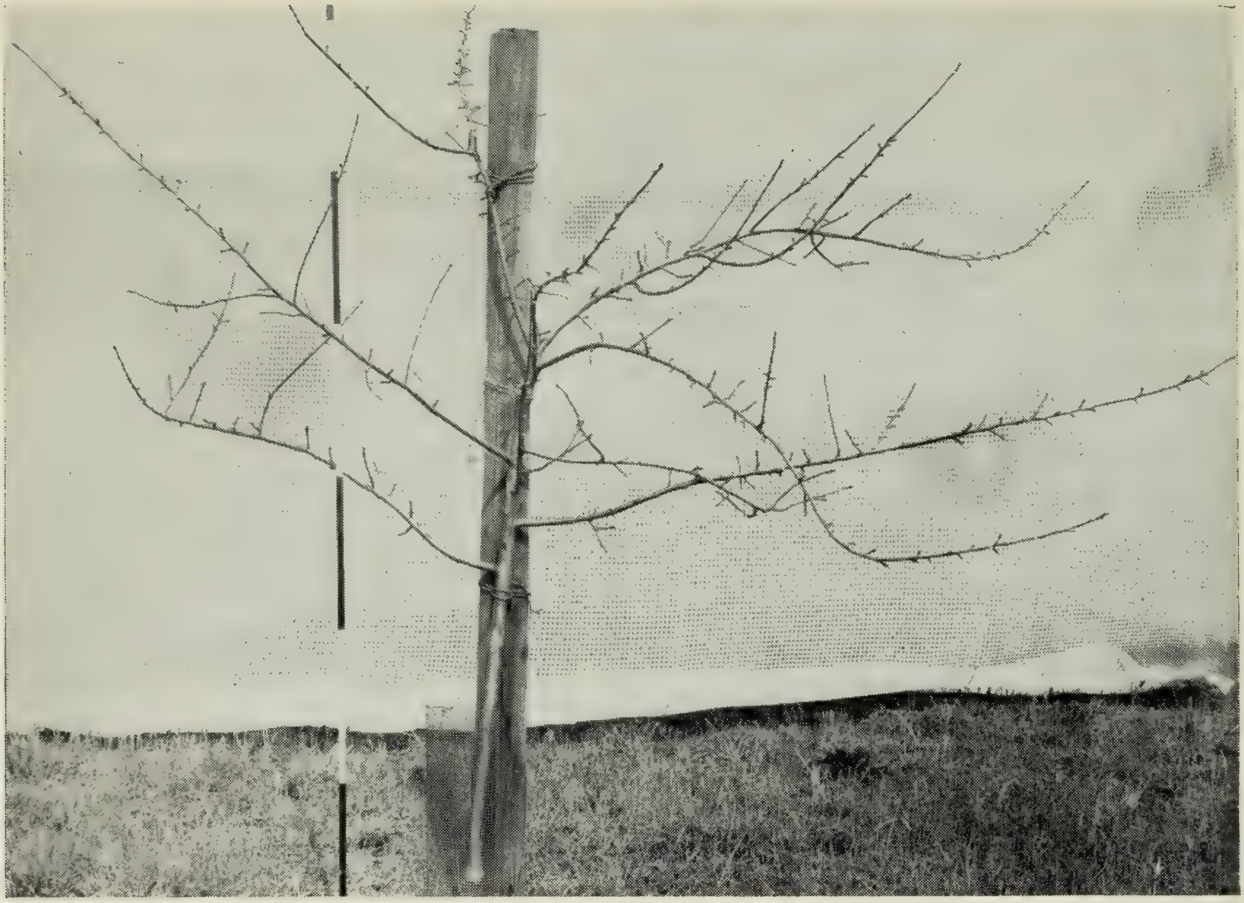

FIG. 3. McIntosh apple on Malling IX five years after planting. Note that the bud union is well above ground level, that the tree is tied with heavy twine in three places, and that a wire guard is used to protect the tree against mouse injury.

wire fence five feet high may be used, if preferred. There is very little danger of breakage of trees tied to fences since it is unusual for more than one post to break off at a time, in which case the fence remains more or less upright and still furnishes considerable support to the trees.

For the first few years it is necessary to keep the main trunk and branches tied to the wires. Then, the branches become interlocked along the wires so thoroughly that tying is necessary only at the extremities or to bring wayward branches in to the wires. Trunk tying is no longer required.

PLANTING

Optimum distance of planting will vary with variety. Where each tree is to be tied to a post the planting distance should be 15 feet each way. However, when trained to a trellis, it appears that 12 feet in the row and 10 feet between rows is satisfactory for apple on Malling IX and pear on Quince A. On Quince C, pear trees could be planted somewhat closer in the row, probably about 8 feet.

Dig the holes wide enough to accommodate the root system without crowding, and shallow enough to have the bud union, usually marked by a swelling from 4 to 8 inches above the topmost root, come at least 3 inches above the normal soil level at this point. To allow this union to become covered with soil at any time during the life of the tree is to invite rooting above the union, and in a few years, a tree of standard size, not a dwarf.

Set the tree upright in the hole and shovel the soil, preferably the top soil first, into the hole. When the roots are nearly covered, firm the soil thoroughly by means of tramping. Add more soil and tramp again, finishing with an untramped mound around the base of the tree. This mound can be two inches above ground level for it will settle after a few rains or waterings. The reader will note that no mention has been made of applications of fertilizer of any sort to the soil being filled around the tree at planting time. Possible injury from this practice rules it out of consideration. Perhaps the only exception would be where the soil is a very heavy clay, when about 12 quarts of moist peat moss mixed with the soil would be expected to give beneficial results. Manure, straw, hay, or sawdust mulches around newly planted trees are recommended if adequate precautions are taken against mouse damage to the trees.

PROTECTION FROM MICE AND RABBITS

Except for the summer months, mice and rabbits are a constant threat to fruit trees. They may feed on the bark any time between September and May. Often the injury may be repaired in a reasonably satisfactory way but only at considerable expense and trouble. The onus is on the dwarf-tree grower therefore to take adequate precautions against injury from these animals. The very best form of protection against mice is the tree-guard made from quarter-inch mesh galvanized wire sunk at least three inches into the soil. The wire cylinder should be large enough to accommodate the tree for several years and with ample overlap firmly wired together at the junction. This guard may be obtained in a number of widths at most hardware stores and could be ordered cut to the length required for each tree. Check the guards early in the fall every year to make certain there are no places of entrance for mice.

Protection against rabbits in the garden is a very much more simple undertaking than it is in the orchard. Where rabbits are known to be present in the vicinity of the garden a temporary fence of chicken wire would be advisable, the fencing being rolled up each spring, and erected again in the fall. This could even be made a permanent fence around the planting if not objectionable from the landscaping angle.

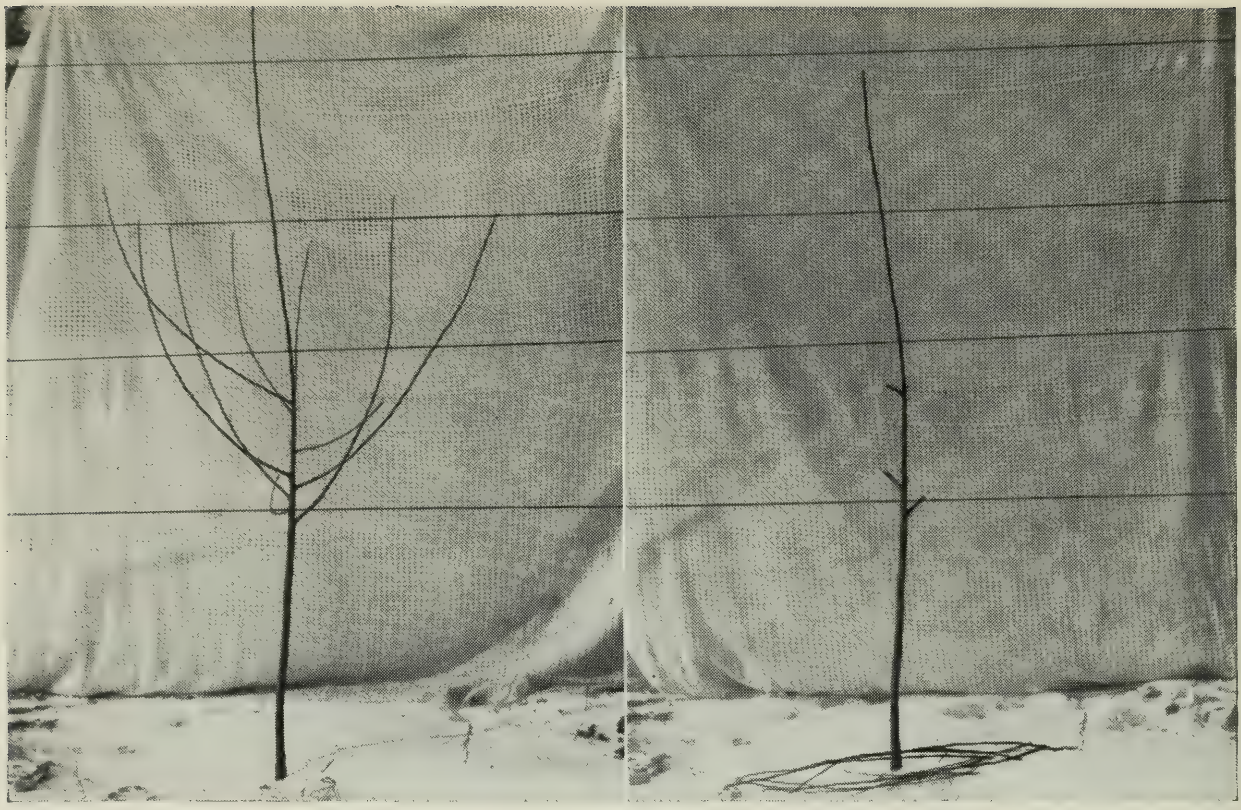

FIG. 4. Two-year dwarf apple tree to be trained to wires before (left) and after pruning (right). After the pruning is completed the trunk should be tied loosely to the wires with a weather-resistant twine.

TRAINING AND PRUNING

Dwarf fruit trees may be trained to many forms, some of them quite decorative. The average Ontario gardener will probably be satisfied with a utility form with emphasis on production rather than appearance. In European countries a specialized summer-pruning program is very common with dwarf trees. In Ontario, this summer pruning does not seem to be required and until there is good reason for changing, the suggestion is to adhere to a dormant-pruning program.

At planting time remove all branches below 24 inches and all branches above that point which make sharp angles (less than 35 degrees) with the trunk. For a tree tied to a post four branches and a leader are sufficient. The branches should be spaced about six inches apart and arranged spirally around the trunk. If the tree is being trained to horizontal wires, the system in use for grapes, the branches should be more or less in line with the wires. It will be unusual to get nursery trees which reach to the top wire and with suitable branches to tie each way along all wires. More likely there will be delay in getting the top arms but within a year or two suitable branches should arise from the leader

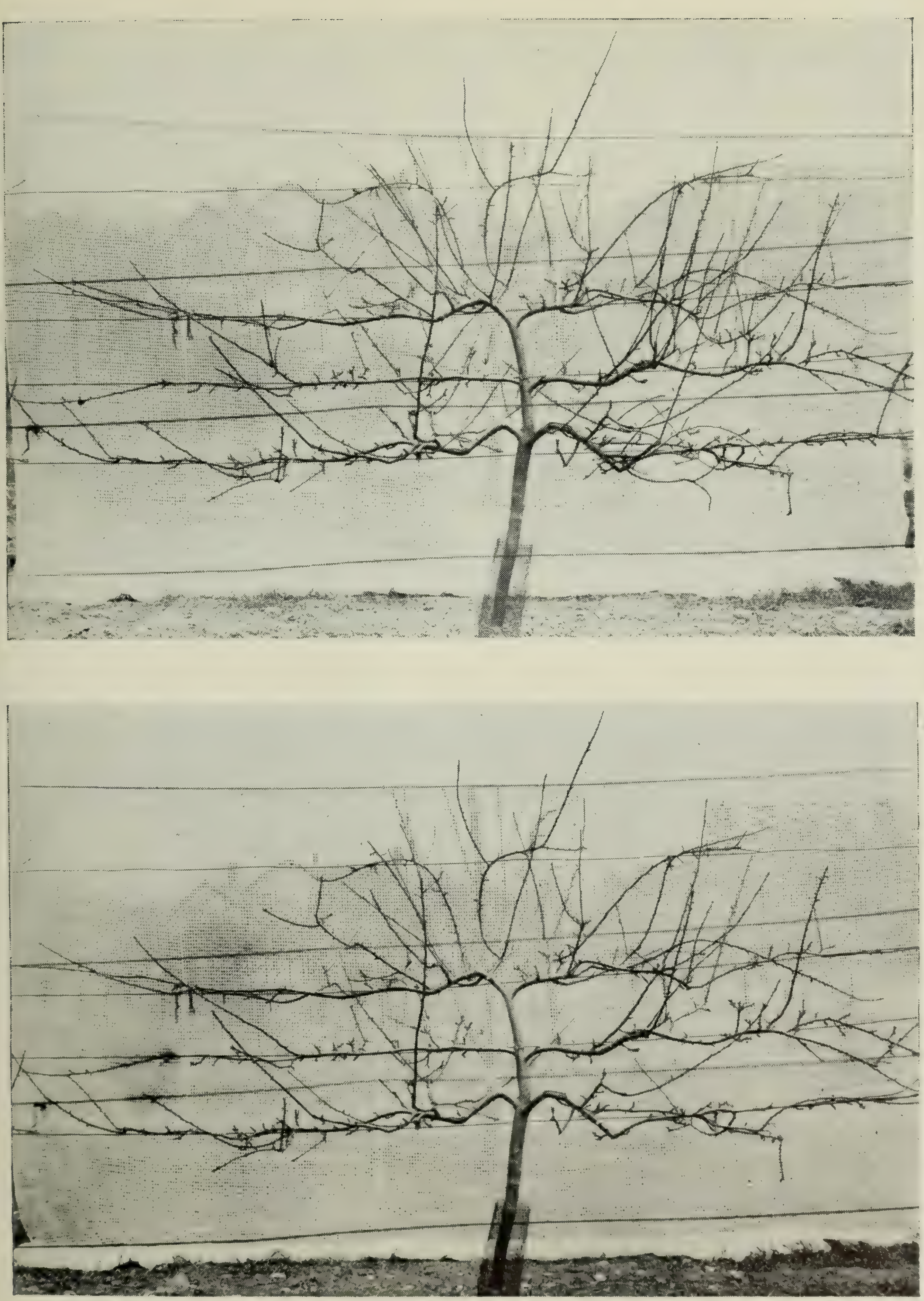

FIG. 5. Cox Orange apple on Malling IX rootstock after growing on wires for eight years before (top) and after pruning (bottom). In this case the top wire was added in the seventh year but might better have been in place and ready for use at planting time.

if it is allowed to grow unhampered by pruning. Cutting away unwanted laterals at planting time and reducing the selected ones to two-bud stubs will encourage the development of laterals from the upper part of the leader. If more of these laterals arise than are needed they should be cut off at the leader.

After the training is completed the trees should be pruned very lightly, if at all, since pruning delays the time of coming into bearing. Furthermore, the bearing of fruit has a pronounced effect in keeping the tree dwarf in stature. There is no evidence to show that dwarf fruit trees need heavier pruning relative to their size than do standard trees. Once the tree has come into full bearing an annual pruning is desirable but it should be moderate in amount, probably not more than ten per cent. of the fruiting wood being removed in any one year. The aim should be to remove dead, dying, broken, and weak branches, those with sharp angles, and a few of the least desirable in thick areas of the tree. Dwarf trees should be kept in a good state of growth by attention to soil fertilization and management rather than by means of stimulation through pruning.

SOIL MANAGEMENT

Most gardens are given occasional applications of farm manure. Under many conditions this is all the fertilization required by dwarf trees. However, if the trees are in sod or semi-sod, or if the grassy weeds are prevalent, an application of some nitrogen fertilizer in the early spring is advisable. The per-tree rate should be from ⅛ to ¼ pound of ammonium nitrate or equivalent for each year of the tree's age, the exact amount depending on the vigour of growth of the previous year. Apply this fertilizer evenly on the ground under the spread of the branches. On account of possible winter injury of poorly ripened wood and of the added danger from fire-blight disease on trees growing vigorously, do not over-stimulate dwarf pear trees by heavy feeding or pruning.

Perhaps the least troublesome system of soil management for the garden involves mulching underneath the tree. Kept sufficiently thick it eliminates weed and grass growth, and in the decay of the mulch valuable nutrients are liberated into the soil where the roots have access to them. For mulching material use strawy manure, old hay, straw, sawdust, or garden refuse. Each fall the mulch should be pulled away from the tree trunk for a distance of one foot to discourage mice from tunneling under the wire tree-guards during the winter. The decaying mulch will usually make unnecessary the application of chemical fertilizers.

SPRAYING

If high quality fruit is to be the goal, spraying is an absolutely essential requirement. Without sprays or dusts, insects and diseases run rampant and the more careful neighbours with fruit trees of their own complain, either privately or publicly. Unless the would-be planter has made up his mind to keep insects and diseases under control it would be folly to go into fruit growing in the garden. There is now available from the Ontario Agricultural College at Guelph, a Spray Calendar for Home Gardens which lists the more important sprays and describes how to make them. These sprays should be considered as a **minimum** number, to be added to if insects are not controlled or if there is abnormally hot humid weather in which diseases thrive. To those dwarf-tree growers seeking perfect fruit the commercial Spray Calendars for Apples and Pears are recommended in preference to the Home Garden Calendar. In any case, maximum yields of high quality fruit can be attained only by keeping the foliage healthy throughout the whole season.

For dwarf fruit trees in the garden there is much to be said in favour of dusting over spraying. It is less "messy", there is less trouble in measuring materials and mixing them, and it is more quickly applied. The more or less all-purpose dust usually recommended is 90 parts dusting sulphur and 10 parts arsenate of lead by weight. This can be used in any small hand duster. It sticks best if applied when leaves and fruit are wet with dew or rain and when there is little wind. These conditions are more likely to be found in the early morning. Dusts do not adhere to leaves and fruit as well as spray, and more applications are required; in fact in addition to the regular times as given on the spray calendars, it is a good idea to renew the dust coverage as soon as possible after every rain. Do not apply sulphur sprays or dusts when the temperature is 85°F. or higher; they may burn the foliage and fruit.

To control aphids (plant lice), when present, a nicotine-lime dust is required. This may be bought in the ready-made state. If there is any left after the dusting it should be kept in a tightly covered can for it loses its potency on exposure to air. Apply this dust on a calm warm day when the temperature is above 70°F.

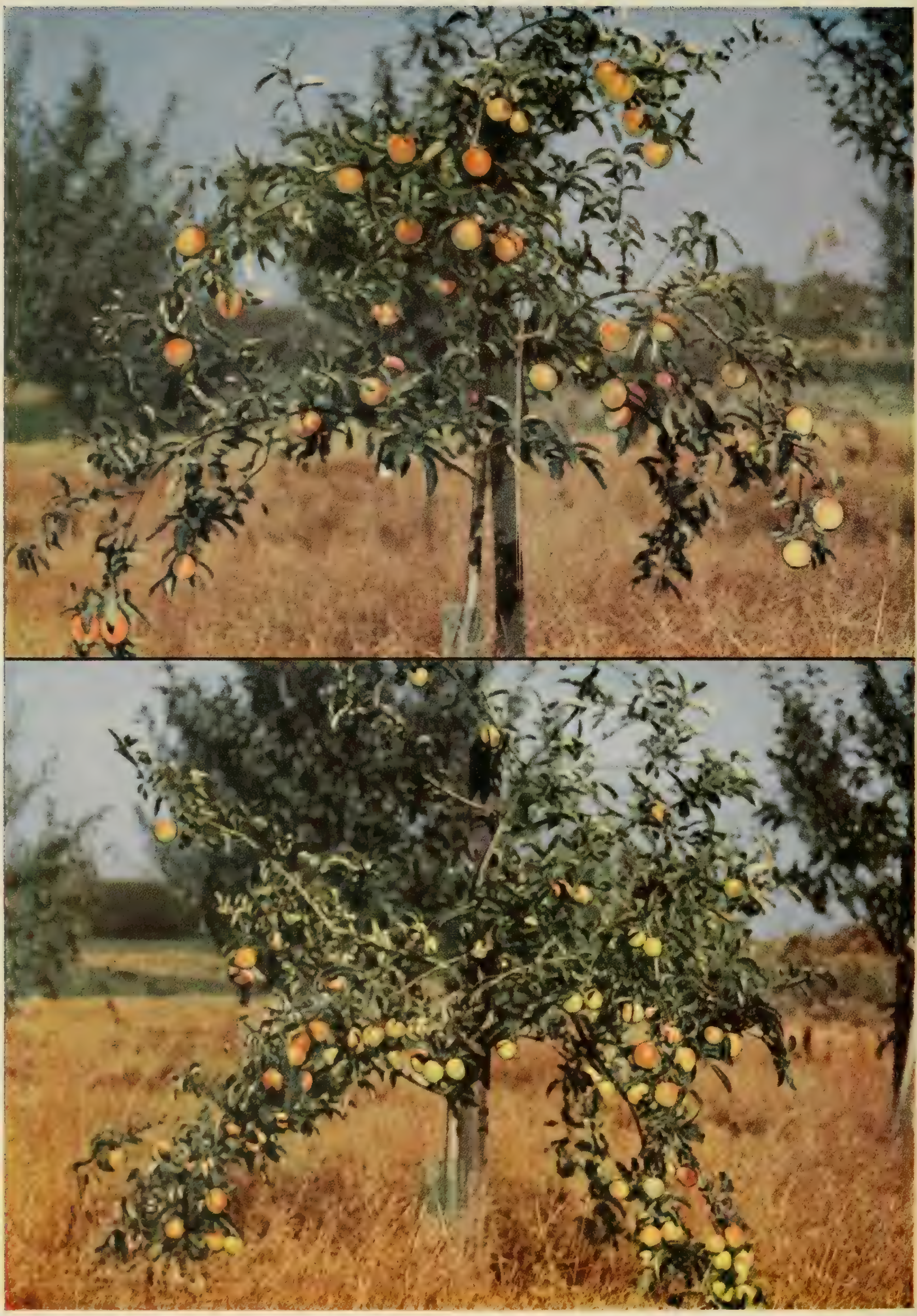

FIG. 6. Golden Delicious on Malling IX thinned (top) and not thinned (bottom). The fruits on the unthinned tree run smaller in size and less mature as shown by their greenish colour. Even if allowed to remain on the tree longer than the thinned fruits they will not attain first class quality.

FRUIT THINNING

With some varieties, especially those which bear only every second year, fruit thinning is necessary if fruit of good size and quality is to be harvested. Thinning is usually done soon after the June drop, itself a natural thinning. It is best to leave the largest and most nearly perfect fruit, removing the others. From centre to centre the fruits should be from 6 to 10 inches apart. If the variety is characteristically large-fruited or if the total load on the tree is not heavy the closer spacing would be preferred. If annual crops are desired from normally biennial-bearing trees a heavy thinning (90% or more) of the newly set fruits is necessary. This thinning must be done within three weeks after full bloom else it will not be effective in inducing annual bearing. Even if annual bearing is attained by this treatment, weather factors may at any time cause a reversal to the biennial-bearing habit making necessary a repetition of the special thinning treatment.

HARVESTING

A high proportion of the fruit of dwarf trees can be picked while standing on the ground. This makes it easily possible to do what the commercial growers call "spot" picking, i.e., picking every day or two those fruits which have reached optimum maturity. This picking over a long period acts similarly, but less in degree, to fruit thinning in the early summer in that it allows the fruits remaining after each picking to have a higher proportion of the sugars manufactured by the leaves.

It is difficult to explain to the inexperienced grower how to determine the proper time to pick the various varieties. Pears attain best eating quality when picked in firm condition and ripened at room temperature, after which they may be kept in a refrigerator to prolong their life. As soon as non-wormy pears begin to drop from the tree, picking should be done immediately for, if left longer, they are likely to go "mushy" at the core before they are at the best eating stage. Most of the summer and fall apples ripen over a long period of time and each fruit may be left on the tree until it is nearly ready to eat. Winter varieties are picked in the firm condition, still too hard for enjoyable eating. To prolong their life they should be kept at a temperature only a few degrees above freezing and preferably under high humidity conditions. As required, they may be taken out of storage and ripened at room temperatures.

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ORCHARD SOIL MANAGEMENT

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By E. F. PALMER and J. R. VAN HAARLEM

HORTICULTURAL EXPERIMENT STATION

VINELAND STATION, ONTARIO

THE FRUIT-GROWER'S DILEMMA—TO CULTIVATE OR NOT TO CULTIVATE
THIS BULLETIN OFFERS SOME HELP.

ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 457 JANUARY, 1948

THE GOOD EARTH

If you would maintain its productive capacity for orchard purposes, observe these fundamentals,—

Know what soil is, and understand its relationship to the plants that grow on it.

Study the particular soil requirements of the fruits you intend to grow, avoiding the use of unsuitable or marginal soils.

Crop production is directly related to the maintenance of soil organic matter. Guard what you have and, if possible, add to it by reducing cultivation, retaining crop refuse, using cover and green-manure crops, adding manure, straw, old hay.

The effect of cultivation is to destroy organic matter. Some tree fruits, as for example, peaches, probably require cultivation even under the most favourable conditions. Even so, less cultivation than now commonly given may be sufficient. The apple, pear, and sweet cherry, often can be successfully grown under a permanent sod-mulch system or, at the least, a greatly reduced program of cultivation. Study your soil and your fruits with the thought in mind of reducing cultivation to the minimum consistent with maintaining satisfactory production. An actual deficiency in nitrogen, phosphorus, or potassium, or an improper balance of these plant foods, may be the cause of unsatisfactory conditions of growth and fruitfulness. Or, "trace" elements may occasionally be responsible. Soil and leaf diagnoses should reveal the cause and indicate the remedy. This service is at the grower's disposal.

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ORCHARD SOIL MANAGEMENT

E. F. Palmer and J. R. van Haarlem

This is a fruit-grower's bulletin, designed to assist him in more fully understanding soil and how best to manage it for his conditions and crops. Where scientific data are given the purpose is simply to give added emphasis to recommended procedures.

Ontario fruit growers are increasingly conscious of the limitations of clean cultivation and correspondingly interested in soil-management methods which will maintain unimpaired the productive capacity of orchard soils. The purpose of this bulletin is to present such methods together with supporting evidence but necessarily leaving to the grower the adoption of the particular management program best suited to his requirements.

The effectiveness of any soil-management practice should not be measured by immediate response alone, particularly of yield, but rather by the performance of the orchard over the entire time that it occupies the land. Additionally, orchard practices should be such that, when the trees are eventually removed, the soil will not have been so impoverished as to be unsuited for further orchard purposes or other agricultural crops. It should be possible by intelligent management to continue orcharding permanently on a given piece of land.

This is hardly the case at present, speaking broadly, and acknowledging that individual growers are handling their soils faultlessly. The problem is to make the exception the rule and thus ensure that present fruit areas continue indefinitely as such. It may be accepted as fact that orchard soils in older established fruit areas of southern Ontario are now definitely less fertile and generally less suitable for orchard purposes than they were 20 to 30 years ago. Certainly they are less suitable than when first planted as virgin soils.

> **"The fertility of an orchard soil is more than its plant food constituent. It involves the nature of the soil, its depth and topography, its previous treatment, the use of fertilizers and manures, the nature of the cultivation, and the covers or sods grown." (Penn. Bull. 294.)**

In the preparation of the accompanying material many authorities have been freely consulted and quoted in order to give substance to the ideas and opinions expressed, to fully develop the varying effects of the factors noted above, and to indicate practices which will favourably influence soils for orchard purposes.

SOILS

ORIGIN AND NATURE

An adequate knowledge of the nature and composition of soil is necessary to an intelligent understanding of its management.

Soil as a whole is simply a mixture of solids, liquids, and gases or air. The solid portion consists of broken down rock (inorganic) plus organic material derived from living things such as roots and plant parts generally, and soil organisms. In this solid portion particles range in size from stones and gravel, through sand and silt, to clay. "Texture" of soil is determined by the proportion of particles of different sizes.

These particles cling together in groups and it is the sizes and shapes of these groups, and their resistance to breaking down which make the "structure" of the soil. This in turn affects soil productivity since it determines the ease of root penetration, the rate of absorption and movement of water, and aeration. A satisfactory "granular" soil structure is as important in plant growth as proper chemical balance of plant foods. In fact nutritional deficiencies are in general easily remedied but fundamental soil characteristics, once disturbed, are repaired with difficulty.

Soils vary in colour depending upon the amount of organic matter present and the accumulation of certain chemical compounds. The darker soils are considered the most fertile ranging through to the yellow, grey, and white which are the least fertile.

> Clay, which has the smallest particles of any solid material in the soil, deserves special mention. These very fine particles, most of which cannot be seen even under a microscope, are called colloids. They represent the last stage in the break-down of larger pieces. Some are made from organic matter, some from mineral matter. The clay particles or colloids are the pantry in which plant foods are kept, the storage place where chemicals are held, to be gradually released to nourish plants. The kind and amount of the clay or colloid portion of a soil is therefore extremely important in determining its fertility.
>
> But before the nutrients can be actually absorbed by roots, they must be transferred to the liquid portion of the soil, the soil solution. This might be roughly likened to a thin chemical soup, made of minerals dissolved in water, which occupies the pore spaces between the solid particles of soil. That is, the soil solution shares these pore spaces with air. Air in the soil supplies plant roots with oxygen, and it is important to maintain the supply by proper drainage.
>
> We live in a moist world, and of all chemical compounds water is the most wonderful and universally useful. A severe drought emphasizes the value of a soil with good moisture-holding capacity. Water is constantly moving in the soil, pulled downward by gravity, and creeping upward, downward, and sidewise in the tiny cavities or pores through the operation of capillary forces—the same forces that pull ink up in a blotter. How water is retained in the soil and how it moves is an interesting but complex subject for study, closely tied up with laws of physics. The vital point is what is called the available water—the amount that is left after all excess has been drained away by gravity, but before so much has been removed by evaporation and transpiration that plants wilt. This available water is capillary water; it is held by capillary attraction in the minute pore spaces. Since structure determines the size and shape of the pore spaces, it is most important in determining the capacity of a soil for holding a large amount of available water. (From Soils and Men.)

AERATION AND DRAINAGE

Some of the fundamental requirements of a satisfactory orchard soil are good surface drainage, a texture which ensures good root aeration, and a subsoil which allows excess water to drain away. Aeration and drainage are closely interrelated as well-drained soils usually are well-aerated soils, and compact, impervious soils are poorly aerated. In these latter soils it is especially important to avoid practices which increase compaction, and in fact underdrainage may often be necessary to reasonably fit them for orchard purposes. Underdrainage however should not be expected to so improve **too** heavy and compact soils as to make them suitable for orcharding.

Waterlogging, a condition in which the soil air spaces are completely filled with water, is due to water entering the soil faster than it can drain away naturally. Fruit-tree roots require large amounts of air in the soil so that even partial waterlogging may greatly interfere with normal root activity. Provided other conditions are satisfactory, underdrainage will usually correct the trouble.

Most of the sandy-loam peach soils of the Niagara District tend to be shallow, the open-textured sandy loam being underlaid by an impervious clay at a depth of 3 to 4 feet. Usually these soils are greatly benefited by underdrainage, which may be complete, or may follow the depressions only. The effect of underdrainage is especially notable in seasons of unusually heavy spring and fall rains as in the fall of 1942 and spring of 1943.

STRUCTURE

The more we cultivate, the greater the loss of structure in a soil, the less fertile it becomes, the more tillage it requires to maintain production, and the less effective tillage becomes.

Good soil structure is that condition in the soil where root growth is stimulated by an open, friable soil, having sufficient aeration, adequate drainage yet sufficient moisture; where aggregates (sometimes called crumb structure) are large and in goodly number, and stable under heavy rains or excessive moisture conditions; where desirable micro-organisms thrive, promoting decomposition — in short, a fertile soil.

As to soil aggregates, Havis, (Ohio Bul. 640) puts it this way:

> "The state of aggregation of a soil does not measure its complete structural composition, but a measure of the degree of aggregation does present one of the major factors concerned.
>
> "Under certain conditions, mineral soil and organic matter particles become united with each other to form crumbs of different sizes. Those which are most concerned in the structure of the soil are stable in water. These aggregates may be considered as units of the soil structure which remain as such during seasonal and moisture changes within the soil complex."

We find these conditions in virgin soil, either under grass or forest cover, where nature has had full sway for many years. Man, by his past cultivation methods, has largely destroyed this natural structure and unfortunately appears to be continuing the practice, which, if not halted, will eventually put present fruit soils out of profitable production.

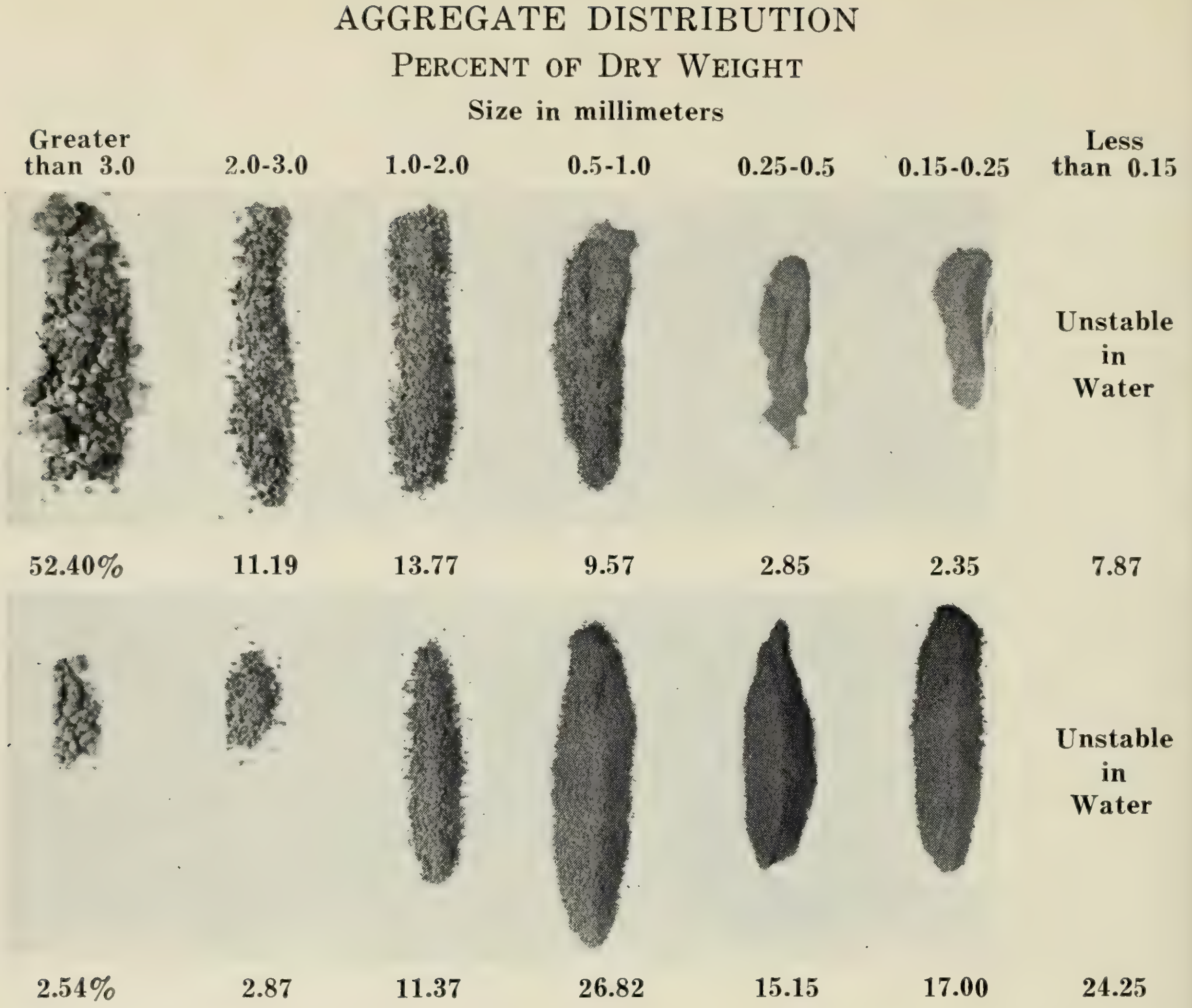

FIG. 1. Soil Aggregates (see Soil Structure, page 7) — Water-stable aggregates largely determine the tilth of a soil. The higher the percentage of the larger sizes the better the aeration, the more easily excess water is drained away, and the greater the micoflora activity, all resulting in increased fertility. The upper picture shows the dry-weight percentages of various sizes of aggregates under a virgin cover; the lower picture shows the same sizes but in a soil cultivated for fifteen years. Note the shift to smaller sizes under the cultivation and, in the last column, the increased percentage of unstable aggregates in the cultivated soil. The photograph fails (because it does not show depth) to properly indicate the much greater bulk of the larger size aggregates, 52.40 per cent, as compared with the smaller sizes. (Photo, courtesy Department of Public Relations, Ontario Agricultural College, Guelph, Ontario.)

Reporting on physical and chemical studies in Ohio vineyards, Wander, (Ohio Bul. 663) makes these opening remarks:

> "During the past 20 to 40 years, grape growers have reported a considerable decline in the yield of grapes on the islands and along the lakeshore of north central Ohio. As an example, in the 1890's there were 916 acres bearing on Kelley's Island, with an average yield of 3 tons per acre. The present acreage on Kelley's Island is about 150, with an average yield of 1 ton per acre or less. These figures are for the Catawba variety.
>
> "This decline in both yield and acreage cannot be entirely attributed to economic conditions or to the increasingly difficult problem of control over insect pests and diseases. Many vineyards are quite old, some being as much as 90 years of age. Others are not as old from the standpoint of age of the vines, but they are on locations which had previously been in vineyards for many years. This means that a large number of vineyards are on sites where the soil has been subjected to the usual vineyard cultural treatments for a long period of time. In other words, the present vines are not growing under the same kind of soil conditions as did the original vines. . . .

> "Originally, thorough and frequent tillage was the best cultural practice because it effected a rapid release of nutrients by the oxidation of accumulated organic matter in the virgin soil. At present, however, excessive tillage simply continues and accentuates the undesirable physical character of the soil which has developed during long periods of tillage. Thorough tillage can no longer release nutrients to the growing vines because very little organic matter remains in the soils of many of these vineyards."

In Canada, Atkinson and Wright, (Sci. Agr. 28:1, Jan. 1948) conclude a study of continuous cultivation **versus** continuous grass as follows:

> "Soil samples from adjacent experimental areas of the Division of Chemistry, Central Experimental Farm, Ottawa, situated on Uplands sand, were taken in 1945. One area has been in continuous grass for 15 years, the other under continuous cultivation. The results of chemical analysis on these two sets of samples were compared with those of soil samples collected from the same location in 1931 when the soil of both areas was considered to be uniform. It was shown that the general level of fertility, as measured by reaction and by content of nitrogen, organic matter, exchangeable bases and readily soluble phosphorous, was decreased by continuous cultivation and increased by keeping the soil in continuous grass."

For our orchard, and indeed all fruit soils, we need to retrace our steps and rebuild degraded soils by using sods and sod mulch where practicable; and otherwise, by less intensive cultivation methods and judicious use of manures and fertilizers in a stepped-up green-manuring program.

SOIL AND PLANT RELATIONSHIPS

Soils and Men, the 1938 Yearbook of the United States Department of Agriculture, clearly states the fundamental relationship of soils and plants in the following words,—

> In all soil management, the important point obviously is the relationship between the soil and the plants that grow in it. With due regard for economic factors such as accessibility to markets, good management consists (1) in selecting the right plants for a given soil, or in choosing the right soil for a given plant; (2) in maintaining the soil so that it remains suitable for the plant; or (3) in modifying it so that it is more suitable.
>
> If a soil is to be favorable for the growth of crops, it must meet six fundamental conditions, some of which can be brought about to a considerable extent by management practices:
>
> (1) It must be suited to the use of efficient cultural implements.
>
> (2) It must offer effective resistance to destructive erosion or depletion under a desirable cropping system. Certain silt loams and very fine sandy loams, for example, are excellent for plants but so subject to erosion that they cannot be used for certain crops for any length of time.
>
> (3) It must be capable of storing enough moisture to meet crop requirements under normal rainfall or irrigation. Texture, structure, and depth to the water table are important factors. The first two, at least, can be modified by proper management.
>
> (4) There must be adequate aeration to permit the development of a good root system. Where this is lacking it can often be provided by drainage; but in heavy, impervious soils or where the water table is near the surface, satisfactory drainage may be impossible.
>
> (5) There must be a supply of plant nutrients sufficient for profitable yields. Here management can be profoundly effective in altering infertile soils by the use of fertilizers, cover crops and manures.

(6) The soil must be free of unfavorable chemical conditions such as excessive acidity or alkalinity, harmful concentrations of salts, or excesses of certain elements that create an unbalanced condition for plants. Here also good management may often correct defects, as by the use of lime to bring about the most favorable soil reaction.

Most of these points, it will be noticed, have to do with the needs of the plant for water, oxygen and nutrients. The success attained in growing plants in water cultures, without any soil whatever, shows that these are the three things on which attention must be centred.

Seldom, if ever, do we find all these conditions present at the same time in optimum degree in land selected for fruit production in Ontario. Much of our land is subject to erosion; much of it is too shallow and frequently poorly drained; much of it, due to poor management in the past, has poor soil structure and low fertility; and much of it is naturally deficient in one or more of the minerals. Our problem therefore is to live with what we have and to so modify present soil conditions by better management practices that our industry will be both profitable and permanent.

PLANT NUTRIENTS

While there will always be exceptional cases in which the so-called minor elements are of importance, yet nitrogen, phosphorus, and potassium are the three elements most likely to worry the fruit grower. (Growers may prefer to think of phosphorus as phosphoric acid or superphosphate, and potassium as potash.)

Nitrogen-Mineral Balance—Fruit trees require a roughly balanced food supply. That is to say, while they may tolerate a wide range of nutrient proportions, yet when one of the nutrients, as for example potassium, becomes excessively low in relation to nitrogen, further applications of nitrogen to "improve" growth simply make matters worse. This happens all to frequently in practice, as growers, noting a lack of vigour and good foliage colour assume that nitrogen is needed whereas in fact its application may do harm. The constant use of nitrogen alone, as practised by many growers, **may** throw both soil and tree out of balance as to their needs for potassium and phosphorus, with ultimate adverse results.

Nitrogen—This ever-changing, fluctuating element is absolutely essential to the maintenance of soil fertility, for without it plant growth would cease. It exists in relatively small amounts in most soils, accumulates very slowly under even the best systems of soil management, and is easily lost through leaching, erosion, and crop removal. It is extremely difficult under any cropping system involving cultivation to maintain or build up the soil's supply. Also the cost of fertilizer nitrogen is relatively high so that, all in all, it is easily the most important element with which the fruit grower has to deal.

Phosphorus—While indispensable, like nitrogen, for plant growth, phosphorus is of less practical importance to the fruit grower. Most soils are as low in phosphorus as in nitrogen, but less of it is removed by crops, and very little is lost by leaching. The main problem is to keep the orchard soil in suitable physical condition, well supplied with organic matter, and approximately neutral in reaction, so that enough phosphorus will become available as needed for the trees. Actual deficiencies can be corrected at reasonable cost by the use of chemical fertilizers.

Potassium—This element is present in most orchard soils, unless the very light types, in considerably larger amounts than nitrogen or phosphorus. The crop removes a large amount and there is also considerable loss from leaching although small compared with that of nitrogen. Next to nitrogen, potassium deficiency, especially as its ratio to nitrogen is important, is likely to be a cause of impaired tree vigour and fruitfulness. In fact general health and vigour seem to be particularly dependent on this element and it is claimed that plants well fed with potassium have greater disease resistance.

Lime (Calcium)—Soil fertility is often regarded as primarily a matter of nitrogen, phosphorus, and potassium supply, overlooking calcium which performs many indispensable functions in plant growth and in modifying soil conditions. Liming has beneficial effects on the soil's "life", its microbiological processes, and on its chemical and physical nature, improving its structure. The value of liming in correcting acidity of orchard soils is perhaps primarily to promote the growth of cover and green-manure crops (legumes especially) as fruit trees themselves are mostly quite tolerant of slightly acid conditions. Also, though lime is not a substitute for manure or fertilizers, yet when needed, its application increases their effectiveness.

Part of a recent symposium on Calcium, (Soil Science 65:1, Jan. 1948) deals with the availability of plant nutrients under various soil acidities. Nitrogen fixation, availability of magnesium, manganese, phosphorus, and potassium, are all reduced when the acidity becomes too great. On the other hand, some elements such as boron, copper, iron, manganese, phosphorus, and zinc become unavailable, and some may even become toxic under very alkaline conditions. The conclusion drawn is that *"pH 6.5* (slightly acid) *is a very favourable reaction for availability of all elements listed and obtained by plants from the soil proper."* Over-liming is therefore as detrimental to plant growth as under-liming and emphasizes the necessity for a soil test to determine the need for lime.

Trace Elements—The role of trace elements such as magnesium, manganese, iron, boron, zinc, and copper is still undergoing investigation. For the most part, Ontario soils appear to be well supplied. In mildly-acid soils the availability of these elements is increased and deficiency is seldom found, but in the more alkaline soils light applications of fertilizers containing trace elements may become necessary. In some restricted areas deficiencies of magnesium and boron have been found and supplements of these materials have become necessary.

ORGANIC MATTER AND HUMUS

Again in **Soils and Men** we read as follows:—

> The scientific study of the soil takes in not only physics and chemistry but biology. All living things supported by the soil return to it in the end, to be broken down by untold numbers of micro-organisms and become the complex substance called humus. This humus is in effect a storehouse of plant nutrients that are gradually released as it is still further decomposed into simple mineral salts, carbon dioxide, and water. But humus represents more than stored plant nutrients; intimately mixed with soil, it has a great deal to do with creating and maintaining good soil structure.
>
> There is no true soil without organic matter. The quantity of humus, however, depends primarily on climate and vegetation. Climate determines the

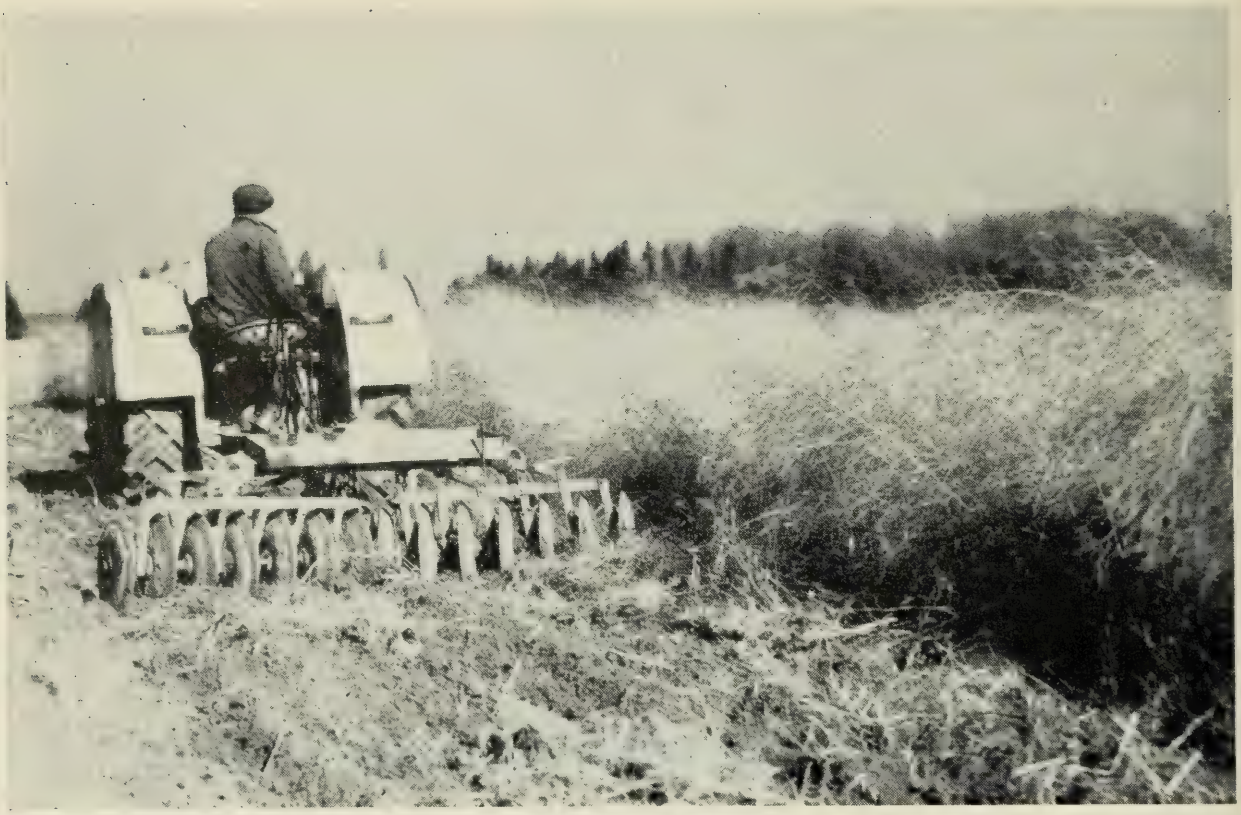

FIG. 2. **Organic matter is the basis of fertility. Return crop residues to the soil. Don't burn them.**

rate and time of decomposition; vegetation determines the amount and kind of organic substance added to the soil each year. In grassland, for example, the quantity of humus in the soil is large; additions each year are not great, but they have been gradually built up because climatic conditions have made the rate of decomposition slow. Eventually all soils under natural conditions reach a state of balance, when the additions of humus from native vegetation equal the removal by decomposition. . . .

When man clears away or plows up the native vegetation, he disturbs or destroys this balance. He may or may not damage the soil, but he must provide for an adequate supply of humus in one way or another if productivity is to be maintained.

The living microscopic organisms that swarm in the soil are the agencies that break down raw organic material into humus, and this again into simpler elements. They do this in the process of getting food for themselves and building up their own bodies. They in turn die, by uncounted billions, to add to the soil organic matter.

NATURE AND FUNCTION OF SOIL ORGANIC MATTER AND HUMUS

The terms "soil organic matter" and "soil humus" are not easily defined or indeed capable of exact definition. However, soil organic matter may briefly be regarded as including such plant material (the main source) as dead roots, leaves, fruits, and stems of plants; carcasses of insects, worms and animals; live and dead soil micro-organisms; and various products of decomposition of the dead residues. Chemically it consists of proteins, carbohydrates, fats, resins, waxes, and similar compounds.

Soil humus represents an **advanced stage** in the decomposition by micro-organisms of organic matter and is a mixture of many different compounds of no definite chemical composition. It is dark in colour and practically odourless. Organic residues whether fresh or in process of decomposition as well as those in an advanced stage of decomposition, which however still resemble the parent material in structure, are not considered a part of soil humus, but are organic matter. Normally the content of soil organic matter, and particularly humus, will be greater near the surface of the soil and will decrease with depth until it disappears entirely.

Some authorities hold that the term "humus" should be used to designate the organic matter of the soil as a whole, irrespective of its stage of decomposition but at present the weight of evidence seems to be in favour of the above separation and definition of organic matter and humus. In this bulletin for fruit growers, to avoid confusion, the term "organic matter" will have preference as an all inclusive one, "humus" being used only where it definitely refers to the well decomposed, more or less stable part of the organic matter of the soil.

The functions of organic matter are to act as a conserver of nitrogen and mineral plant nutrients, to regulate their liberation for the use of growing plants, and to modify certain physical and mechanical properties of the soil such as structure, colour, consistence, and moisture-holding capacity. As an example, the formation of the granular structure most favourable for plant growth is governed by the organic-matter content of the soil. In its role as conserver and regulator of plant nutrients organic matter is invaluable. It may be likened to a governor or balance wheel which maintains soil fertility since it is the natural storehouse of moisture, of nitrogen, and of much of the minerals.

Active organic matter, in process of decomposition, supplies food and energy for micro-organisms whose activities are essential to make a soil productive. In a general way therefore soils well supplied with organic matter are the most productive, and as organic matter is depleted, ability to produce crops declines. Here it should be understood that a **rich** soil is not necessarily a **fertile** soil, fertility depending upon the availability to the growing plant of the foods present. Thus we see that chemical fertilizers alone may correct nitrogen or mineral deficiencies but fertility and therefore crop response depend upon the presence of adequate amounts of organic matter. Soils low in organic matter may sometimes produce good crops, given very favourable seasonal conditions and perhaps careful use of chemical fertilizers, but such productivity is neither natural nor lasting.

Ohio authorities, noting the effects of loss of organic matter, report an increase of 16.5 pounds in weight per cubic foot of soil, a decrease of 9.3 per cent in porosity, and a loss in organic matter of 4,000 pounds per acre, in a soil cropped for 40 years, as compared with a virgin soil. In other words the loss of organic matter has made the soil definitely more compact in character and correspondingly less suited to plant growth.

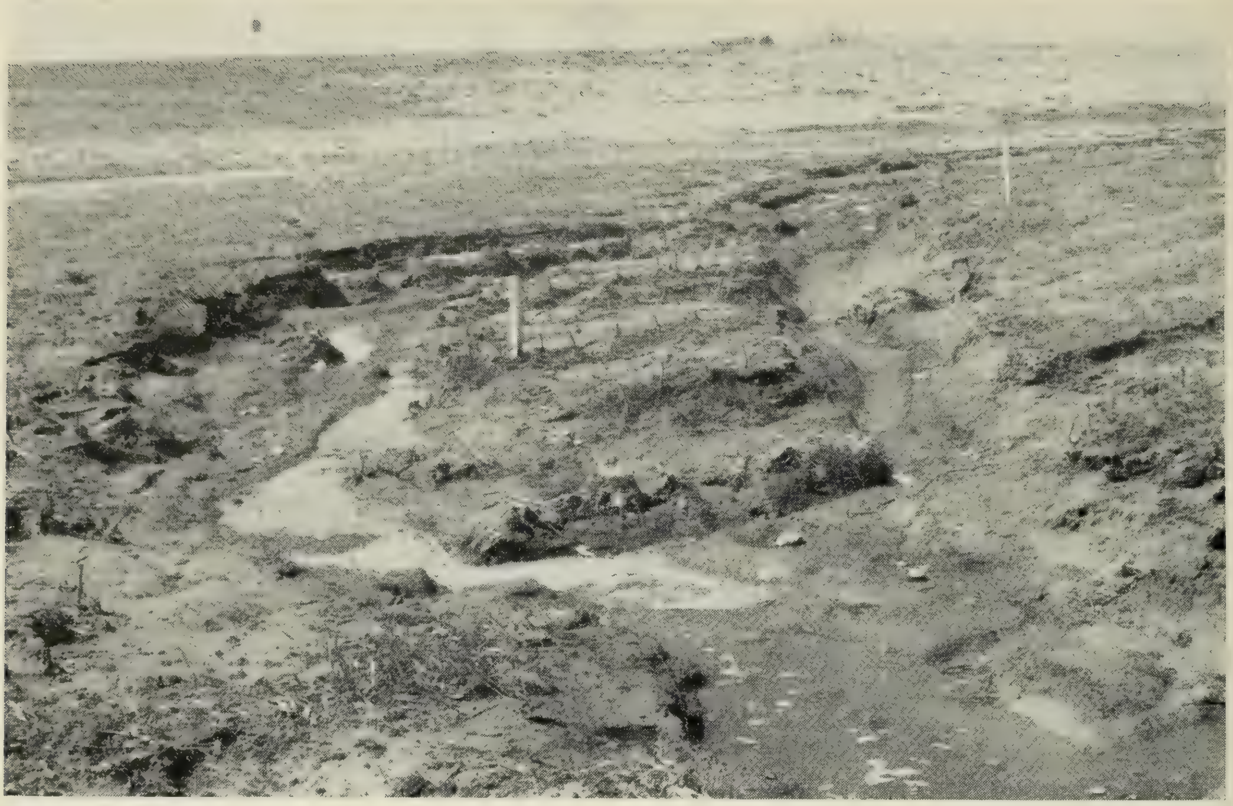

FIG. 3. Soil erosion. In cultivated orchards loss of rich top soil is often serious. Gullies should be left continuously in sod as in Fig. 4, the land on either side being treated as separate orchards.

ORGANIC MATTER AND WATER RELATIONSHIPS

The importance of water in crop production is self-evident. The part that organic matter plays in the moisture-holding capacity of a soil and in absorption and movement of water cannot be over-emphasized.

A soil's capacity to retain moisture is in direct proportion to the fineness of the soil particles—the finer the particles the greater the water-holding capacity so that a clay, for example, is much more effective than a sand or sandy loam. Decomposed organic matter (humus) is even finer than clay and its water-holding capacity is several times greater thus indicating its importance in even the finest-textured soils. In the coarser soils, since their inherent water-holding capacity is proportionately less the coarser they are, humus content is correspondingly important.

Expressed in percentage, increased water-holding capacity due to humus increase may seem small, but an increase of 1½ per cent (a very conservative one) in available water in the top six inches of soil represents, according to New York workers, 3,750 gallons per acre, or with 50 trees (apple) to the acre, 75 gallons per tree. This is an increase in **capacity, not amount**, so that after every good rain there could be this much more water available in the top six inches of soil; thus in the course of a season several times 75 gallons might be available for each tree.

This increased water-holding capacity is of prime importance in smoothing out seasonal distribution of rainfall. Too often summer droughts, even of short duration, are held responsible for partial crop failure when in actual fact faulty soil management and low humus content are responsible. The soil must take rain when it comes, holding it in anticipation of later crop needs, its capacity to do this depending on its humus content.

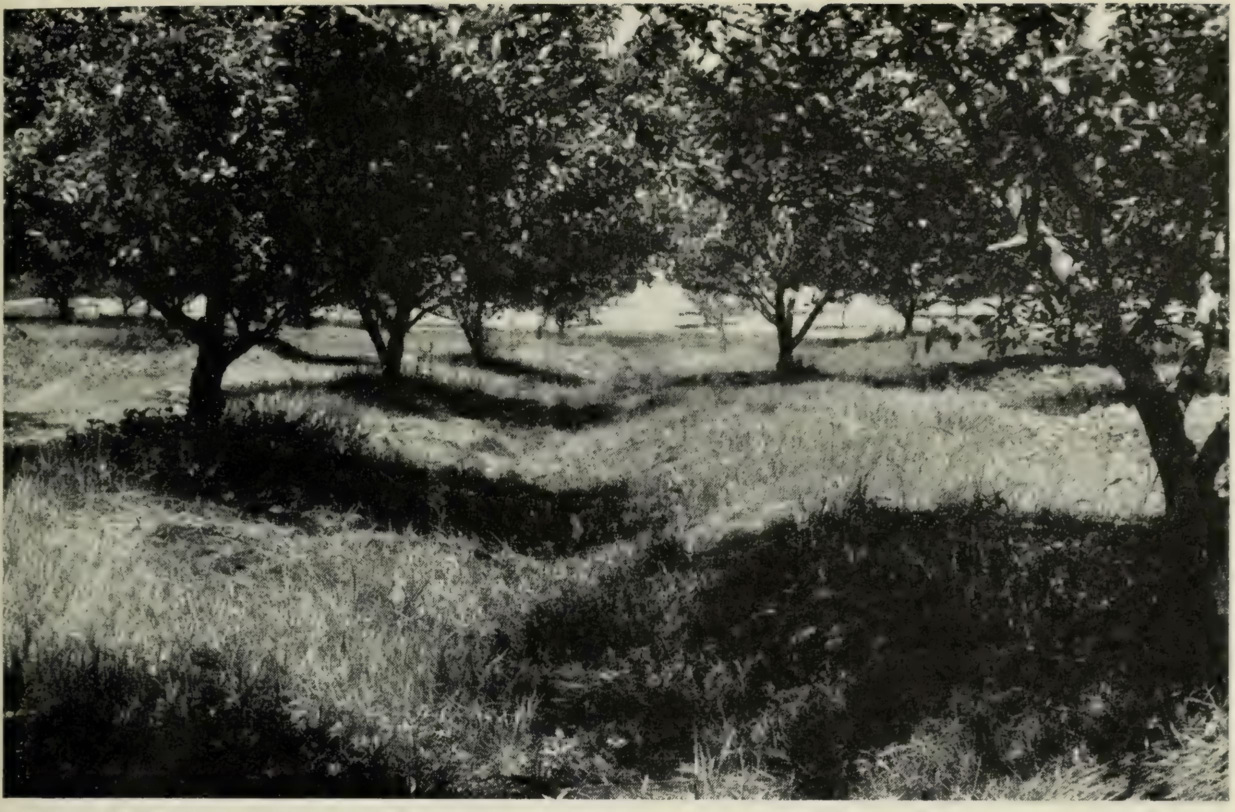

FIG. 4. Permanent sod along water courses or gullies reduces erosion in cultivated orchards.

ORGANIC MATTER UNDER ORCHARD CONDITIONS

The trees themselves will supply some organic matter chiefly in the form of leaves, especially where they do not easily blow away as under sod conditions or where fall plowing is **not** practised. Substantial amounts of organic matter must, however, come from other sources, cover and green-manure crops, weeds, farm manure, sod, straw, old hay.

COVER AND GREEN-MANURE CROPS

Green manuring, either alone or in conjunction with the use of farm manure, must be a continuous process to maintain organic matter as there is no very large addition from the turning under of a single crop. In fact the objective in green manuring is to maintain rather than increase organic matter. Actual increase where needed will have to come either from a change in cultural practice or from additional material brought in.

In green manuring the maturity of the crop determines the amount of organic matter added to the soil. Young succulent material decomposes readily, and quickly releases plant nutrients for fruit-tree use, but it has little effect on the total soil organic matter. On the other hand, plants allowed to mature before being returned to the soil decompose more slowly and are of much greater value as sources of organic matter.

Green-manure crops, planted in **late** summer and plowed or disked early the following year therefore add little organic matter, but do re-

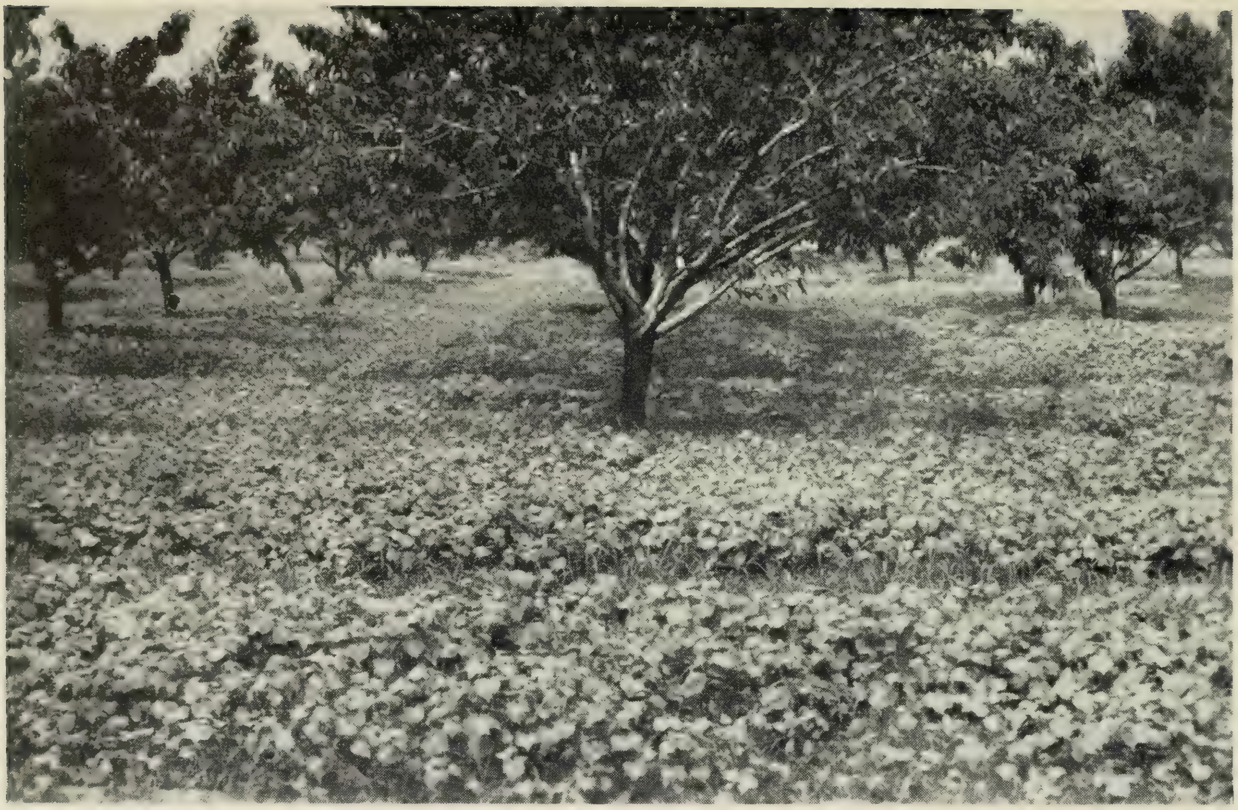

FIG. 5. Continuous use of buckwheat as a green-manure crop may lead to some destruction of soil texture. Rotate buckwheat with other green-manure crops, as annual sweet clover, millet, mixed grains, soybeans.

lease plant nutrients when the trees can make good use of them for early, vigorous growth. Green-manure crops planted in **early** summer, as where minimum cultural practices are followed, (See page 31) will mature by fall, and will therefore add very considerable amounts of organic matter. The individual grower will vary his practice to suit the needs of particular soils and fruit crops.

Cover (over-wintering) and green-manure crops may be divided into two classes, leguminous, and non-leguminous. The **leguminous** crops, **alfalfa, clovers, peas, soybeans, vetch,** have the ability to store nitrogen from the air through the activity of the bacteria living in nodules on their roots. When the plant dies, or is turned under, nitrogen is liberated sufficient for its own decomposition plus a surplus for following crops. In orcharding, more particularly apple orcharding, legumes have the same fault as farm manure, slow release of nitrogen, which may unduly prolong tree growth and delay fruit maturity to the detriment of both tree and fruit.

If a soil has not previously grown legume crops it is best to inoculate the seed with a culture of bacteria peculiar to that crop so that the production of the nodules on the roots is stimulated. These cultures are obtainable from Agricultural Representatives, the Ontario Agricultural College, and most seed houses. After the first crop is grown the soil will be sufficiently inoculated for succeeding crops of the same kind.

The **non-leguminous** crops include **barley, buckwheat, various grasses, millet, oats, rye, Sudan grass, sunflowers, fall wheat, weeds.** These crops have not the ability to store free nitrogen and, for abundant growth, must be supplied with nitrogen from fertilizers or other sources.

Also, these crops when turned under need considerable nitrogen for the bacterial decomposition of the plant material. The millets and rye are heavy consumers of nitrogen during their growing period and the following period of decomposition. If the extra nitrogen is not supplied they will compete with the trees for nitrogen, often to the disadvantage of the trees. Thus we sometimes find that when a heavy crop of rye or millet is plowed under without additional nitrogen, a nitrogen deficiency in the tree will be indicated by pale foliage colour.

Cover and green-manure crops may also be classified as deep or shallow rooted. The deep-rooted crops, such as alfalfa and sweet clover, penetrate well into the subsoil from which they obtain not only plant food but also large quantities of soil moisture. This may sometimes work against the tree, robbing it of needed moisture during hot weather. These deep-rooted crops, by penetrating into the subsoil, help to open it up so that tree roots can penetrate more freely and tap the available minerals in the subsoil. Young orchards, however, are particularly susceptible to the competition of these deep-rooted crops which, when sown, should therefore be kept well away from the trees.

Cover crops can be a valuable aid in holding winter snows and preventing soil erosion. Any crop that stands stiff and straight throughout the winter will hold snow and prevent drifting. The snow cover not only adds soil moisture but also prevents the deep penetration of frosts. During the spring, in orchards where run-off occurs, a remaining cover-crop will prevent the rich topsoil from flowing down the ditches. Erosion is an insidious thing, very often not appreciated until serious results are in evidence and it is too late to hold or restore the rich topsoil. Make use of cover-crop residues to prevent or reduce erosion.

With cover and green-manure crops it is often good practice to apply a low-nitrogen complete fertilizer (such as a 2-12-6), just previous to planting to stimulate growth. Having the crop take up some minerals during the summer season is an indirect means of fertilizing the tree with minerals in an organic form, for on decomposition these plant residues give up these minerals in a readily available form. Fertilizers for this eventual use should not be put on in heavy amounts as it is not desirable to overstimulate the trees at that time of year. An application of 125 to 250 pounds per acre is ample.

Green-manure crops, leguminous and non-leguminous, known to have value for Ontario conditions, or otherwise of interest, are briefly discussed in the accompanying paragraphs.

Alfalfa—Alfalfa does not make a good green-manure crop because of insufficient spring growth by the time it should be turned under, but makes a good permanent sod and is widely used for this purpose. (See page 27.)

Buckwheat—Buckwheat is used extensively as a green-manure crop for orchards. The seed is cheap, germinates well, and when sown at 1 to 1½ bushels per acre, gives a good ground-cover. However, on the basis of present knowledge, its extensive and repeated use as an orchard cover is leading to a destruction of soil structure (see Rotation of Green-Manure Crops, page 34).

When buckwheat is to be grown, sow at the time of the last cultivation, about June 15th. The first seeds will ripen in approximately eight weeks and a light disking at this time will thresh out enough seed for a good volunteer crop the same season. Where buckwheat is used as part of a minimum-cultivation program, follow this schedule—cultivate the first two weeks of the season, sow the buckwheat, trash-disk when the first seed is ripe, allow the volunteer crop to grow till fall and let stand over winter.

Hubam Annual Sweet Clover—An annual form of sweet clover which does not live over winter. It produces very rank growth which will require frequent cutting under orchard conditions. As with alfalfa and biennial sweet clover, better germination is obtained by the use of scarified seed.

Italian Rye Grass—This biennial grass, sometimes called "Domestic Rye Grass", is being planted in increasing amounts each year. As a cover crop it behaves similar to rye, stooling out to form a thick, short, ground-cover by fall, growing again in the spring to a height of 12 to 16 inches, and forming seed. The grass has a narrow leaf, forms a thick top-growth, and has a very shallow but dense root-system. Dry weight of top growth per acre equals and frequently surpasses that of rye. Italian Rye Grass should be planted about June 1st at 12 to 15 pounds per acre. Sow with a drill rather than broadcast as this grass is difficult to clean out of the tree or vine row.

Italian Rye Grass is particularly useful as a cover crop for peaches and grapes, serving as an excellent over-wintering ground-cover, and is also well suited to other tree and small fruits. Being a biennial it will commence growth early in the spring and can be disked down when a foot high, or about May 15th.

Ladino Clover—(see also page 27) Ladino Clover, like biennial sweet clover, may be used as a cover crop, planted after the last cultivation and trash-disked the following May. However, Ladino seed may be too expensive for this purpose at the present time.

Millets—Millet varieties are divided into two types, hay, and grain, the hay type being leafy and the grain type non-leafy. The hay or leafy type belongs to the foxtail group, has slender stems which grow 2½ to 5 feet in height, broad flat leaves and bears seed in dense cylindrical heads. The very leafy varieties of this type provide dense ground-cover and draw great quantities of moisture from the soil, which in wet seasons is a good point but in dry years is a detriment to the orchard. However, in orchards that are generally too wet, these would be good crops to take up the excess moisture. Varieties of this group are — Common, Empire, Hungarian, Japanese, and Siberian.

The grain or non-leafy type comes in the proso millet group and is characterized by having panicle heads with large seed. The stems are coarser, except the variety "Crown," grow 2 to 5 feet in height and bear fewer, narrower leaves. They have a shallow root-system and in dry weather practically stop active growth. This type does not use the quantities of soil moisture that the leafy type does and therefore will not compete with the trees during dry weather to the same extent. Varieties in this group are—Crown, Hog, and Red Turghai.

In general, millets draw heavily on the available soil nitrates, very often at the expense of the trees. The effect on the orchard, or on a following green-manure crop, is therefore a nitrogen deficiency. Thus a millet crop sown in early summer may adversely affect the stand and growth of a succeeding rye crop. To partially overcome this effect an application of

125 to 250 pounds of 2-12-6 just previous to sowing these crops will avoid nitrogen competition with the trees, and the minerals will in addition be of immediate benefit to the green-manure crops and ultimate benefit to the fruit trees.

Mixed Grains—Mixed grains, sown June 15th, can be used as a green-manure crop if cut when reaching a height of about 18 inches. The crop is shallow rooted and will not draw too much upon soil moisture. A heavy weight of easily-decomposed plant material is possible. It is a good smother crop for weeds.

Oats—The common varieties of oats are too subject to leaf rust under our conditions and consequently do not make sufficient growth. By using the variety Beaver, better results will be obtained because it is more resistent to leaf rust.

Rape—Some years ago rape was used extensively as a green-manure crop but growers have found it too wet during harvesting operations due to slow drying after rains and heavy dews. Rape is easily grown and provides a thick ground-cover but does not add much organic matter to the soil. Also it is very subject to aphis attack.

Rye—Rye has been used for many years as an orchard cover-crop, sometimes at the expense of the orchard. It is a particularly heavy nitrogen feeder during its rapid spring growth and if the weather then is too wet to plow rye down there is a serious nitrogen drain which adversely affects the trees. Frequently rye is in head and three to four feet high before soil conditions are such that it can be turned under. A further nitrogen drain then occurs when this large volume of maturing material is plowed under and decomposition gets under way. This competition for available nitrogen has been the cause of severe damage to trees. On the other hand, in good seasons of normal spring weather, rye is an ideal cover crop. Before incorporating the rye in the soil a light application of nitrogen should be made to hasten decomposition and lessen competition.

Soybeans—Soybeans are one of the best annual, leguminous, green-manure crops and should be included in every orchard rotation where cover and green-manure crops are used. One-year seed should be used and it should be inoculated with the correct type of bacterial culture if it is the first time this soil has grown soybeans. It has also proved worthwhile to dust the seed with Spergon or Arasan to prevent fungus disease of the young seedlings. The seedbed should be well prepared, the seed sown 1 to 1½ inches deep, and the soil well firmed after seeding, otherwise germination will be poor.

Sudan Grass—This grass belongs to the sorghum family and grows best in good "corn weather", germinating well in hot weather and growing three to four feet high in the orchard. It forms a thick ground-cover and is a good smother-crop for weeds. Because of the thick cover it should be lightly disked in the fall to discourage the harbouring of mice during the winter. Before plowing down Sudan grass in the spring a light nitrogen application should be made to promote decomposition. At Vineland, Sudan grass has not given as high yields of dry matter as Crown, Empire, and Japanese millets.

Sunflowers—This crop may be used as a green-manure crop planted June 15th, or at time of last cultivation. Sown with the grain drill through the oat chute set at 6 pecks, it requires from 1½ to 2 bushels of seed per

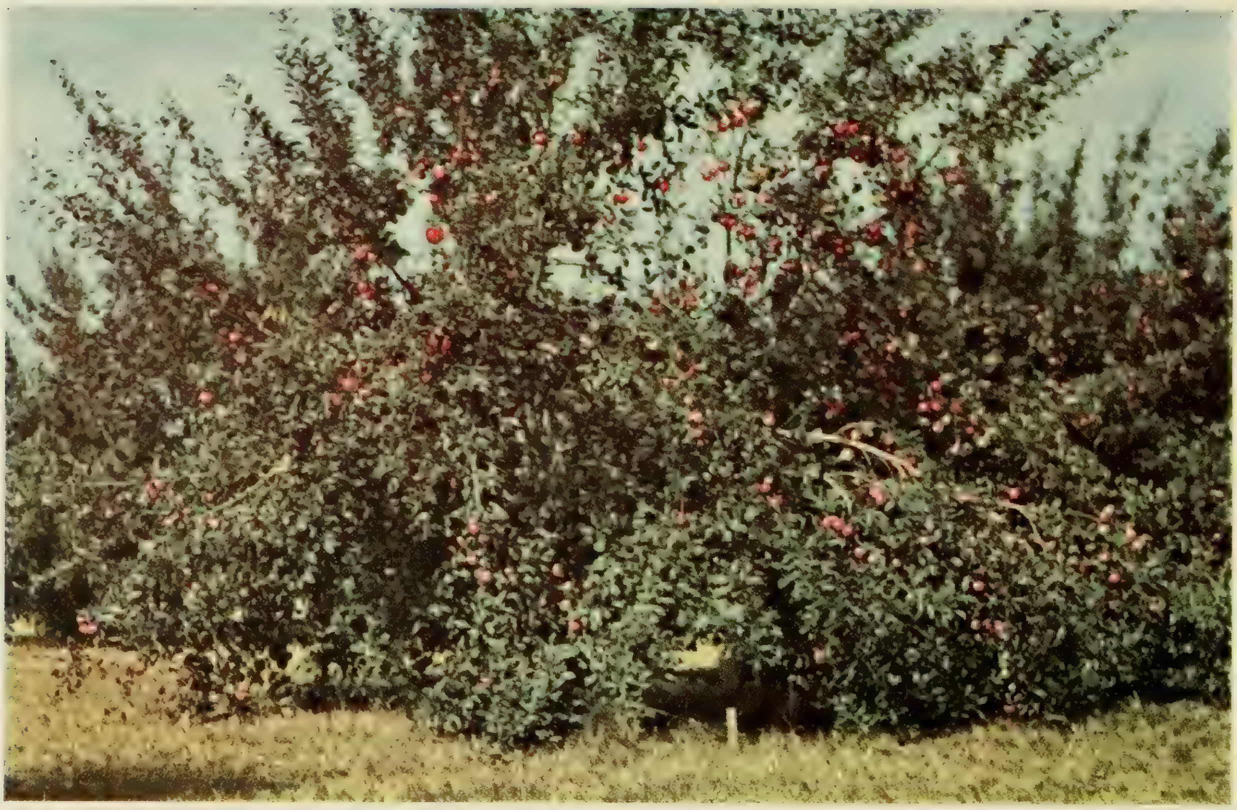

FIG. 6. Color is improved, yield is maintained under minimum cultivation methods, providing there is adequate fertilization and intelligent use of green-manures, sods, sod mulches.

acre. It can be grown in rows and cultivated, in which case it requires 20 to 30 pounds of seed per acre. With the thicker planting through the grain drill this crop yields about five tons of dry matter per acre if it is cut when 3 to 4 feet high. The real value of this crop is in this enormous tonnage of dry matter.

Sweet Clover—Sweet clover is a biennial crop, dying out completely the second season after planting unless it becomes self-seeded or is reseeded by hand. As a green-manure crop, planted **late** one season and turned down **early** the next spring, sweet clover has not given entire satisfaction because of insufficient growth by the time it should be turned under. However, as a semi-permanent sod, it is a very useful crop, penetrating and opening up the subsoil, adding considerable nitrogen and a fair amount of organic matter. To obtain its greatest usefulness as a cover or green-manure crop it should be planted with a nurse crop (which can be mowed when necessary during the season), allowed to grow late the next spring and then trash-disked before the growth becomes woody. Handled in this way, in orchards that would fit such a program, sweet clover will yield a fair tonnage of organic matter and add considerable nitrogen to the soil. Better germination is obtained by the use of scarified seed.

Vetch—This crop is seldom planted alone — usually as a mixture with rye, the combination giving an increase of organic matter over either crop separately. The mixture has the further advantage of some free-nitrogen fixation by the vetch.

Weeds—Failing the planting of any other green-manure crop a good stand of weeds will yield large quantities of plant material to turn under. Many growers object to the untidy appearance of the orchard and the tall stiff stems left standing during the picking season. Mow the weeds once or twice during the season as they reach a height of 18 to 20 inches. When finally incorporating the crop, a very light application of nitrogen should be given to stimulate breakdown and prevent a nitrogen drain on the orchard. Handled in this way weeds can be a satisfactory source of organic matter. Incidentally, weed growth in an orchard is usually a fair index of soil fertility. Soils which won't grow weeds won't grow green-manure crops either, and eventually won't grow satisfactory fruit trees or crops unless and until fertility is restored by building up the soil organic-matter.

Time of Planting Cover, and Green-Manure Crops—Several factors combine to complicate this problem. Seasonal climatic variations, age of trees, condition or vigour of growth, soil type and condition, all enter into the picture. Newly-planted trees, or a young orchard, should not be handicapped in the early part of the season with other crop competition for moisture and plant nutrients. Planting in June or July is therefore recommended. On the other hand, over-vigorous young trees may be checked to advantage by an earlier seeding, the competition in this case being necessary to curtail excessive growth.

TABLE I — MANAGEMENT OF COVER, GREEN-MANURE, AND SOD CROPS

	Seed per acre	**Time of seeding**	**How Managed**	**Nitrogen requirement**
*Alfalfa	15-20 lb.	May	cut as required	none needed
Bluegrass	25-30 lb.	May	cut as required	in the fall
Buckwheat	1-1½ bu.	June	left over winter	none needed
Chewing's Fescue	10-12 lb.	June	cut as required	in the fall
Grass Mixtures	16-24 lb.	May	cut as required	in the fall
Hubam Annual Sweet Clover	15-20 lb.	June	left over winter	none needed
Italian Rye Grass	15-17 lb.	July	left over winter	in the spring†
*Ladino Clover	5-7 lb.	May	cut as required	none needed
Millets	20-30 lb.	June	left over winter	in the spring†
Mixed Grains	1½-2 bu.	June	left over winter	in the spring†
Orchard Grass	15-18 lb.	May	cut as required	in the fall
Red Fescue	18-20 lb.	June	cut as required	in the fall
Rye	1½-2 bu.	September	left over winter	in the spring†
Rye and Vetch	1 bu. Rye 30 lb. Vetch	September	left over winter	none needed
Sod Mixtures	(see page 28)			
Soybeans	1½-2 bu.	June	left over winter	none needed
Sudan Grass	25-30 lb.	June	left over winter	in the spring†
Sunflowers	1-2 bu.	June	cut when 3-4' high	none needed
*Sweet Clover	15-20 lb.	June	left till May 15th	none needed
Weeds			left over winter	in the spring†

* Sow with a nurse crop. On sandy land can be seeded alone.

† Nitrogen Requirement—Where spring applications are indicated apply the nitrogen before working the soil, then disk (or plow). Fall applications are on permanent sod. For rates of application see page 46.

Excess moisture conditions due to seasonal variations in rain may be partially offset by early planting of either a very leafy, or a deep-rooted, green-manure crop. The draining off of excess moisture through the green-manure crop, especially in the fall, enables the trees to properly mature both fruit and wood.

MANURE AND OTHER ORGANIC MATERIALS

Farm Manure—In general farming putting manure back on the land is the natural means of returning to the soil as much as possible of the fertility removed in crops. In orcharding it is usually the case that manure is not produced in sufficient quantity to supply the need and must therefore be brought in from near-by general farms or from city stables and stock yards. Even then it will be the case, more often than not, that there is insufficient manure for all orchard demands, and other materials and methods as discussed in this bulletin, will have to be substituted.

Manure varies in the amount of plant food which it supplies, i.e., nitrogen and minerals, but even though low in these elements it is a dependable source of valuable organic matter. In fact this is probably its chief value rather than the actual plant food present. The benefits are largely indirect being accomplished by improvement in physical condition of the soil, water-holding capacity, aeration, favourable effect on soil organisms, etc. Reference should also be made to organic substances variously termed "plant growth substances", "accessory growth factors", "vitamins", and concerning which very little is yet known. Farm manure however has long been known to strikingly increase plant growth more than can be accounted for by the actual plant food it contains. This extra value may be due to the presence of plant-growth chemicals which stimulate root development or otherwise assist the plant.

In orcharding, manure should be used with caution, especially for apples, as it supplies slowly-available nitrogen which may delay tree maturity and adversely affect fruit colour, quality, and storage life.

Recommendations as to the best time of application for farm manure still remain where they were—in the spring, just previous to the time it can be incorporated into the soil. When we consider that approximately 57 per cent of the fertilizing elements of manure are in the liquid portion and that 68 per cent of the total fertilizing elements in manure are water soluble, we can see that manure, if left exposed to the elements for long periods, is subject to leaching and run-off. Manure on frozen ground is therefore not economical. However, in the spring, the fruit grower is often harassed by lack of help, or lack of time because of other necessary operations. In this case it would be better, for the cultivated orchard, to apply the manure when convenient during the winter rather than omit it altogether, application being made to the level areas first, where run-off would not be excessive. It must be borne in mind that, in decomposing, manure releases nitrogen slowly and over a long period. If applied in too large amount in early spring, the slowly available nitrogen may delay tree maturity and adversely affect fruit colour, quality, and storage life.

Farm manure on sod orchards serves a useful purpose during the first few years after seeding by stimulating the grass to form a sod quickly. After the sod is well established it should not be necessary to use manure, nitrogen applications alone being sufficient.

Grape Pomace and Canning Factory Waste—These materials are available in fairly large amounts at local canning plants and wineries. Generally they are low in fertility, and fairly acid. Grape pomace is composed of seeds, skins, and stems, and is usually dry enough to break up into small particles. An average analysis would be 1.25% nitrogen, 0.5% phosphate, and 1.72% potash. It has been used at 3 tons per acre with good effect and will help improve the structure of the heavier soils.

Canning factory waste includes seeds, skins, and culled pulp, and is usually very wet. Its analysis is quite variable, depending on the product used, but in any case it is low in fertility and quite acid. Adverse soil effects, followed by death of trees, have been noted where this sloppy product has been applied as a layer an inch or more thick over the orchard soil, reducing aeration and nitrification and generally adversely affecting the structure of the soil. Therefore only a very light coating should be applied, carefully spread, and some lime added. The drier these products are, the better their effect when used as organic additions.

Pea straw is also available from the viners in those sections growing green peas for processing. In using this straw, with its high nitrogen content and rapid decomposition, care must be taken not to apply it too deeply around the tree as a mulch, as this has sometimes resulted in winter injury due to late growth.

Hay and Straw—With the scarcity of manure in fruit districts it has been difficult to find suitable substitutes for the manure usually applied. Straw and hay are good substitutes for manure; in fact, as a source of organic matter alone the substitute may be cheaper than manure itself. An average manure contains from 75% to 80% water so that in a ton the dry matter amounts to about 500 pounds only. Dry straw and hay, on the other hand, have upwards of 1,700 pounds of dry matter per ton. As to fertility, an average manure contains 10 pounds of nitrogen, 5 pounds of phosphoric acid, and 10 pounds of potash per ton. A glance at Table II is convincing evidence of the fertility value of straw and hay as compared with manure, although manure has other values as already suggested.

Hay or straw is put on the orchard in late fall at the rate of two tons per acre, and lightly disked to partly break it up and incorporate it. If legume hays are used no nitrogen supplement to aid decomposition is needed since these hays already have a high nitrogen content. The non-legume hays and straws need about 150 pounds per ton nitrate of soda (or equiv.) to hasten decomposition and prevent competition with the tree. One-half of this amount is broadcast over the material when applied and both are lightly disked. Early the next spring, previous to the regular spring operations, the remaining half of the nitrogen should be applied. Treated in this way two tons of straw or hay are the equivalent in organic matter of about seven tons of manure. Growers using straw or hay should be careful not to apply more than three tons per acre.

Paunch Manure—This partly-digested fodder taken from the stomachs of animals killed in the abattoirs is sometimes used for manuring, although it is not the equal of farm manure. Paunch manure is acid in reaction and, because it is only partly digested, is fibrous in nature. Especially if used as a mulch therefore, lime should be added to counteract acidity, and nitrogen to aid decomposition. Even where used in moderate amount as a manure substitute it is well to add lime and nitrogen.

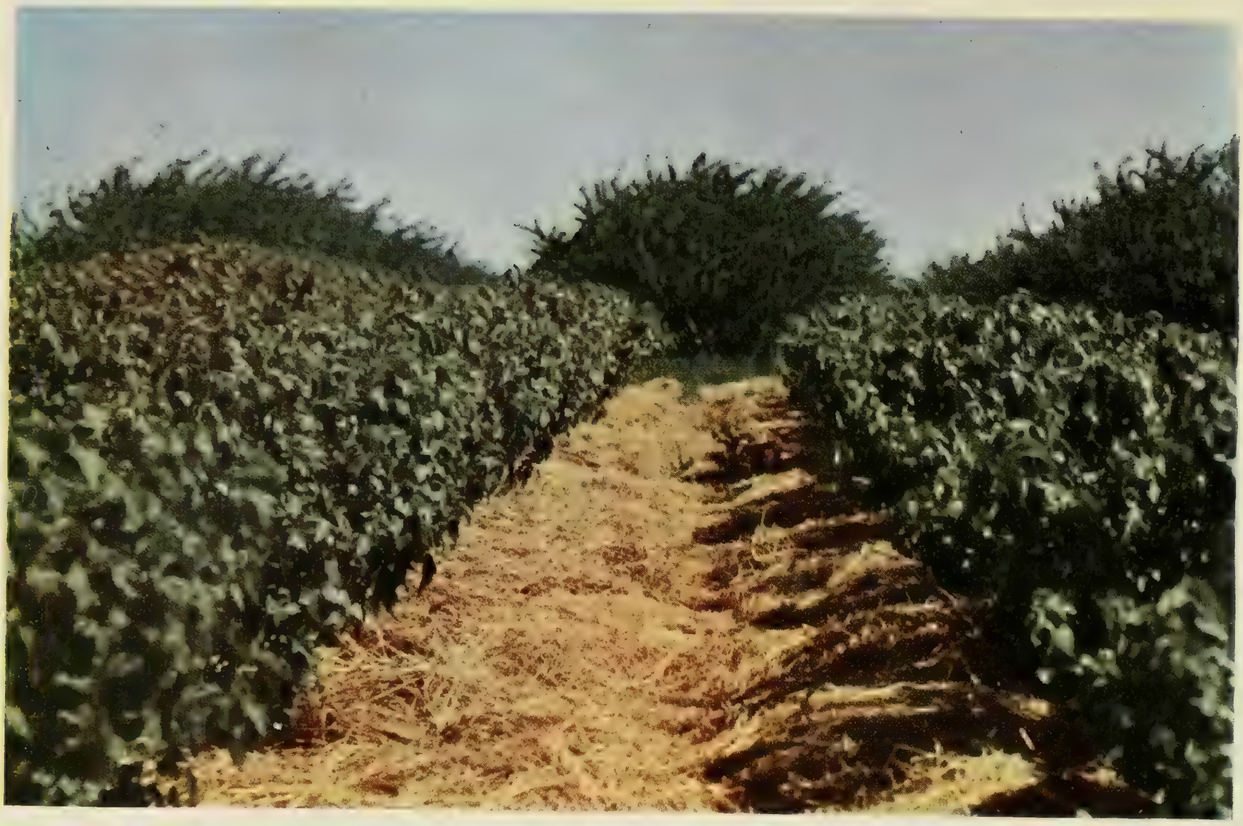

FIG. 7. Mulches should be considered for currants and gooseberries as well as for tree fruits.

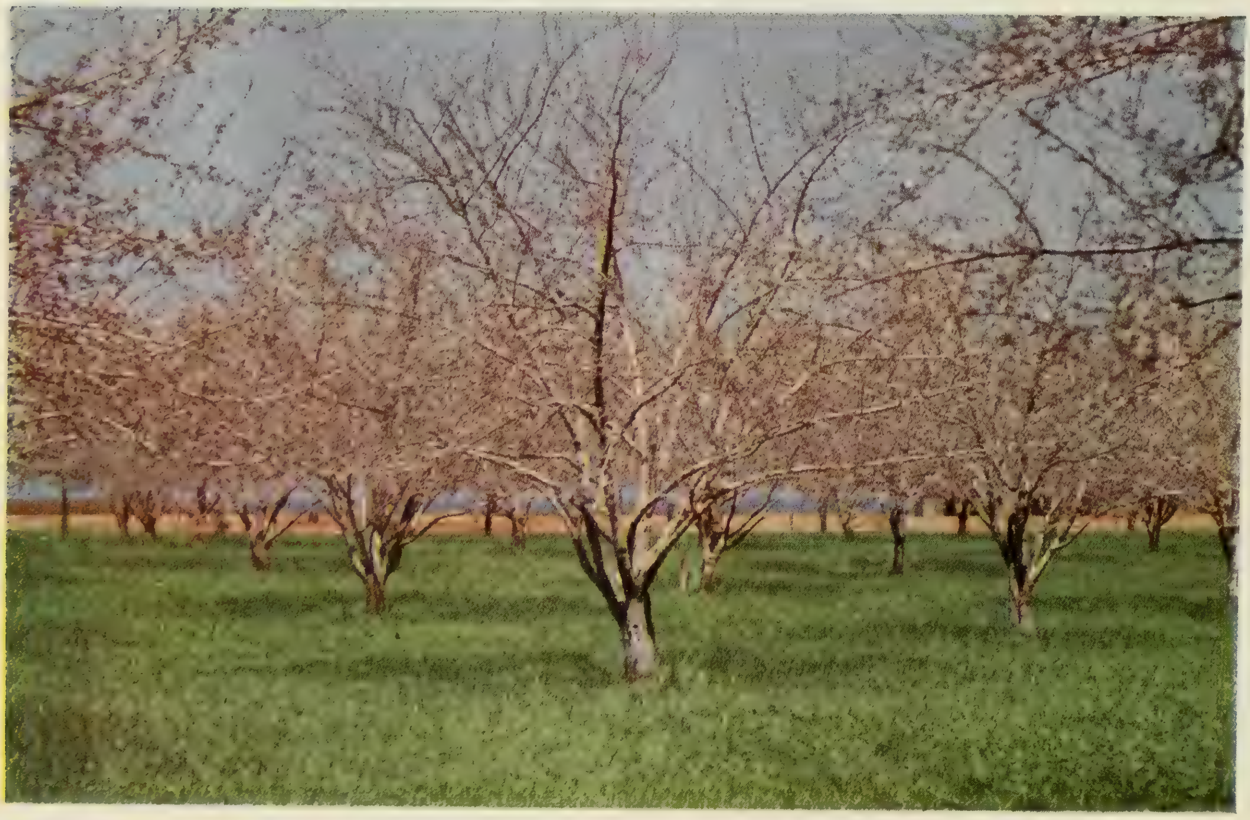

FIG. 8. Sod orcharding to be effective requires adequate fertilization, both for the tree and for the sod. Production and profits decline under a "neglect" program. The sod in this orchard is bluegrass and Ladino clover.

Table II — Manurial Value of Farm Residues*

Crop	Approximate Pounds Per Ton			
	Nitrogen N	Phosphorus P_2O_5	Potash K_2O	Dry Matter
Alfalfa straw—threshed	43.8	10.2	33.6	1840
Barley straw	16.7	5.6	30.7	1716
Bean straw—threshed	38.0	7.8	25.6	1790
Clover straw—threshed	42.6	11.0	28.2	1838
Oat straw	12.0	4.0	26.0	1816
Pea straw—from viner	20.8	7.0	19.8	860
Pea straw—threshed	38.0	7.8	25.6	1790
Rye straw	12.0	6.0	17.0	1858
Wheat straw	11.0	4.0	20.0	1808
Alfalfa hay	49.0	10.0	42.0	1832
Clover hay	42.0	10.0	40.0	1742
Soybean hay	46.0	14.0	22.0	1828
Timothy hay	25.0	11.0	20.0	1816
Buckwheat	13.0	7.1	24.2	1802
Corn stover	15.0	8.0	18.0	1600
Leaves, Mixed	16.0	6.0	6.0	1832
Marsh grass	17.2	10.6	54.0	1720
Millet	14.0	3.6	34.0	1730
Peat moss	16.0	2.0	3.0	†
Sawdust, shavings	4.0	2.0	4.0	†
Cow manure, fresh	6.8	3.2	8.0	460
Hog manure, fresh	9.0	3.8	12.0	540
Horse manure, fresh	11.6	5.6	10.6	600
Mixed stable manure, fresh	10.0	5.2	12.6	482
Poultry manure, fresh	32.6	30.8	17.0	880
Sheep manure, fresh	16.6	4.6	13.4	720
Paunch manure, fresh	Too variable for stated analysis.			

* Compiled from various sources.

† Moisture content variable.

Poultry Manure—Many growers are using poultry manure in orchards and berry plantations, much of it mixed with straw litter. This manure is very high in nitrogen and if applied in heavy amounts may cause some trouble. An application of 3 tons of the litter per acre should be the maximum amount used at one time. Droppings without the litter should be applied with extreme caution and certainly at reduced rates.

Sawdust, Shavings, Peat—As our supply of farm manure dwindles recourse to other materials becomes a necessity. Winery and canning factory wastes, sawdust, shavings, and peat, are therefore coming into more general use. Sawdust, shavings, and peat are extensively used as bedding materials and this litter is now used in the fruit areas.

Sawdust and shavings have been reported by various experiment stations as giving increased crop returns, through retention of moisture rather than addition of plant food. However, as indicated below, where seasonal rains are light, sawdust and shavings used as a mulch under the trees may hold all that falls, with little or none penetrating to the soil. As litter material in stables, sawdust and shavings readily absorb the liquid excrement but unfortunately, since their fixation of ammonia is practically nil, most of the nitrogen is lost into the air. As a carrier of the liquid excrement and as another source of organic matter they do have definite value.

Fibrous peat and peat moss from our extensive bogs of this material are a worthwhile source of organic matter. Peat not only has fine absorptive powers for moisture but is unexcelled in its fixation of ammonia. It has been used as a mulch under trees, thick enough to stop growth of grass and weeds. However, Turk and Partridge, of the Michigan Agricultural Experiment Station, recently reported (Soil Science, 64:2, Aug. 1947) that evaporation from peat mulches was far more rapid than from any other material used in their experiments. They conclude as follows:

> "Effectiveness of the different mulching materials in decreasing moisture loss from Hillsdale sandy loam was in the following descending order: straw, corn stover, alfalfa, shavings, gravel, sawdust, and peat. With the exception of peat and possibly sawdust, it is doubtful whether the differences among the other materials were significant.
>
> "Peat and, to a much less degree, sawdust, have such a high absorptive capacity for water that with light rains or with long intervals between rains relatively little water reached the soil.
>
> "These results definitely indicate the value and effectiveness of certain types of mulching materials in the conservation of moisture. Since soil structure is one of the most important limiting factors in fruit production in Michigan on certain soils, this is of particular importance on the more droughty soils."

It would seem therefore that mulching materials such as straw or hay are the most effective and, as long as they remain available, should be used. When the supply runs out recourse to other materials will become a necessity. However, the objections raised by Turk and Partridge would not hold if sawdust, shavings, or peat, were used as a source of organic matter, spread thinly over the soil, (instead of as a mulch under the trees) and incorporated by cultivation where that is practised, or left to decay on the sod. An application of two tons per acre annually is adequate for this purpose.

SOD AS A SOURCE OF ORGANIC MATTER

Left to itself, as for example in grassland, a soil slowly enriches in organic matter, finally reaching a state of balance where the additions from the grass or other vegetation equal the removal by decomposition. Under orchard sod conditions therefore the organic-matter problem solves itself, it being necessary nevertheless to provide that the fruit tree does not suffer from competition for food and moisture. This may be accomplished, as later discussion suggests, by the use of mulch, and commercial fertilizers where needed.

Loss of organic matter, accumulated under sod conditions, begins with cultivation, and the longer it is continued, other things being equal, the greater the loss. This is not **necessarily** to be deplored as the decrease is in large part the necessary accompaniment of making the organic matter useful to the tree. But if allowed to go too far, unaccompanied by replenishment, the eventual result will be declining growth and lowered yields. Soil management should be so planned as to provide for a level of cropping which can be maintained without impoverishment of the soil itself.

There are several crops which are suitable for orchard sods. These are discussed in subsequent paragraphs. In general, success or failure in establishing any of these crops is usually dependent on preparation and subsequent care of the seedbed. For the finer grasses particularly, sowing early on a well-prepared seedbed and packing after seeding is an essential. Permanent covers are usually sown by broadcast application, either by a grass-seed attachment on the grain drill, by cyclone seeder, or by hand. However sown, they should be packed or rolled after seeding. See Table I, page 21 for rates and times of seeding.

Alfalfa—Alfalfa, being a legume, gathers nitrogen, and may sometimes gather too much, or at least release it too late in the season, for the good of the tree. Deep rooting, with consequent desirable opening up of the subsoil, is another characteristic of alfalfa. Due to its own needs for nitrogen alfalfa may have a temporary adverse effect on tree growth for two or three years, or until well established and, when cut and used as a mulch, it has become effective in releasing nitrogen and minerals and in conserving moisture. Alfalfa, as a sod in the orchard, should be cut more frequently than for hay in order to keep a short, green cover on the soil. This reduces competition with the trees and lessens moisture loss through excessive transpiration. The use of scarified seed will give better germination.

Bluegrass—Grass sods are particularly useful for sweet cherry and pear orchards where the nitrogen supply should not be maintained too late in the season. Pears, and particularly the Bartlett variety, are more subject to fireblight if the nitrogen supply is excessive or maintained too long, as with manure, increasing sucker growth and generally resulting in a soft condition of the wood, which condition is conducive to the disease.

Generally, in sod-grass mixtures, after the sod becomes firmly established, it will be found that bluegrass predominates. The question therefore arises as to whether it would not be advisable to plant the sod with these grasses in the first place. However, the other grasses in the mixture are desirable in that they insure a thick cover quickly. For apples, pears and sweet cherries, bluegrass sod is quite satisfactory. See Sod Mixtures, page 28.

Chewing's Fescue—This New Zealand grass is finding increasing favour in Michigan as a sod for cherry, peach, and plum orchards under sandy soil conditions. It may have equal value for Ontario, especially on our deeper, lighter soils. In Michigan, seeding is usually done in August, with 100 pounds of ammonium nitrate per acre to give the grass a good start. In Ontario the low-moisture conditions usually prevailing during July and August make it advisable to sow this crop earlier than in Michigan; seeding in June, and fertilizing in the fall, is therefore recommended.

Chewing's Fescue is tough, wiry, and low growing, and requires little moisture during dry weather, when it becomes semi-dormant. It forms a dense top of comparatively short grass which is cut when it becomes nine inches high. The dense but fibrous root system is very shallow and yet the turf is strong enough to support heavy orchard machinery.

Ladino Clover—This mammoth form of white clover has proved useful as a sod crop for orchards in the Niagara district. It grows profusely under orchard conditions and should be cut several times during the season, when about fifteen inches high. Ladino clover grows well when seeded alone at six pounds per acre, or it can be used in orchard mixtures, one to two pounds being added per acre. The seed is very small and difficulty may be experienced trying to make six pounds cover an acre. Mixing it with sand or some other suitable medium usually helps. This clover can be broadcast in the spring by hand on top of the ground, on bare spots and places inaccessible to a drill, with a high percentage of seed germinating.

Red Fescue—This member of the fescue family is a persistent, perennial, turf grass which grows well under shady conditions and should therefore do well in the orchard. It commences growth early in the spring and forms a close turf of very fine grass, becoming somewhat wiry later in the season. The sod will stand a lot of abuse and should stand up under the use of heavy orchard machinery. Red fescue may be seeded in the spring or in early September.

Sod Mixtures—A sod mixture that has done exceptionally well is composed of red fescue 12 lb., alfalfa 12 lb., perennial rye grass 6 lb. per acre. The perennial rye grass is here used as a nurse crop and usually dies out during the first winter. The fescue-alfalfa mixture grows better than either crop separately, the fescue minimizing winter heaving of the alfalfa, and the alfalfa supplying nitrogen for the fescue.

Another good combination is Kentucky bluegrass 20 lb. and Ladino clover 2 lb. per acre. This mixture has made good sod under orchard conditions at Vineland.

An all-grass sod which grows well in shade and is tough enough for heavy implements is red fescue 20 lb. and perennial rye grass 5 lb. per acre. Here again the perennial rye grass is used as a nurse crop.

CUTTING GREEN-MANURE AND PERMANENT SOD COVERS

There is some evidence to show that close cutting of orchard covers is reflected in better growth of trees. This may be due to a lessened moisture and nutrient competition with the trees and to a more rapid turn-over of nitrates from the rapidly-decomposing, succulent material. At the same time, the trees may also be benefited by the improved physical condition of the soil resulting from organic additions and root effect, this improvement being most marked under permanent sod conditions.

Orchard covers, and especially the permanent sod covers, should be mowed three or four times each season rather than once or twice only. The most critical period for permanent covers is mid-September during which time they normally store food for the winter period. Cutting at this time might therefore be injurious to the sod. A suggested schedule for cutting **permanent** covers would be the 1st of June, July, August and September, and not during the remainder of the season, rather than a schedule governed by height of the crop. However, it must be borne in mind that seasonal conditions of moisture and temperature greatly affect the growth of these covers and cutting dates may have to be advanced or delayed accordingly.

Annual green-manure covers, and this includes a crop of weeds, should be mowed when they become 15 to 18 inches high, before fruit harvest, and either mowed or trash-disked at the end of the season to discourage mice.

During dry weather, particularly in July and August, it is most important to lessen moisture competition for the trees by cutting the cover, whether annual or permanent.

SYSTEMS OF HANDLING ORCHARD SOILS

For apple and pear orchards particularly, the trend of the past 15 to 20 years has been away from clean cultivation towards other systems, notably sods and mulches. Even young trees succeed under sod if properly handled although there may be advantages in cultivating the young orchard until it reaches bearing age. (See Table IV.)

In tree fruits other than the apple and pear the disposition is to reduce cultivation from the excessive and unprofitable "summer fallowing" of recent years, although not to the point of sod culture which is perhaps too extreme for the stone fruits,—peaches, plums, and sour cherries. For sweet cherries, if soil conditions otherwise are right, sod is quite feasible.

Pennsylvania Bulletin 373, **Orchard Soil Management,** reporting on a survey of representative orchards and vineyards has this to say,—

> The findings show clearly for residual soils in particular, where moisture shortage is a frequent limitation to yield and vigor of tree, that clean-cultivation leads to soil depletion, manifesting itself in the form of decreased organic matter and nitrogen and diminished permeability. Condemnation of clean-culture as a system of orchard management appears inconsistent with the fact that many clean-cultivated orchards are profitable, but these profits are obtained at the expense of the soils' destruction. Clean-cultivation must eventually lead to premature abandonment of the particular site. Several peach and grape growers whose soils are included in this study have agreed that their clean-cultivated blocks are being "run down". This depletion has been caused by sheet and gully erosion which was commonly encountered on clean-cultivated sites. Orchards which were cover-cropped annually suffered less loss in soil and water while not a single permanently sodded site was encountered on which the subsoil was exposed or on which gullies were to be found.
>
> It is believed that these findings demonstrate what has taken place in the past and point the way to what must eventually take place in the future. Soil structure and permeability must be maintained, because if not maintained, the lack of them, eventually though slowly, will lead to increased runoff and erosion. The loss of water at critical periods and the loss of top soil will eventually lead to decreased vigor of tree and yield, and premature abandonment of the site. Those soil conditions which tend to preserve the permeability and fertility of the soil are shown to be present when permanent sod or rotated sod occupies the ground. Such systems introduce new problems in orchard management, such as moisture and nutrient uptake by the cover, rodent injury, greater fertilizer requirement, and others, but it seems best to find solutions for such problems than to be forced to cope with the more difficult one of a depleted soil.

In reporting on the relation between organic matter and available moisture under different orchard cultural systems which had been in effect for 25 years, Ohio workers state that the total amount of organic matter was less under cultivation, even though cover crops had been used, than under the mulch and sod treatments; and these differences in organic matter resulted in significant differences in available moisture.

The effects of organic-matter losses through cultivation, if not compensated for by replacement, become evident in the burnt out, droughty condition of sandy soils and the lack of good tilth, and poor physical condition of heavier soils. Sooner or later, as indicated in the Pennsylvania quotation, and depending on the kind of soil, the original organic-matter content, the climate as regards temperature and moisture, and the extent of cultivation, the organic matter may become so low that a permanent agriculture can no longer be maintained. It is perhaps unfortunate that these adverse effects are less quickly evident with the deeply-rooted tree fruits than with shallow-rooted field crops, as otherwise the fruit grower would be more alert to the problem.

The problem is general. In New York Agr. Exp. Station Bulletin 632, for example, R. C. Collison writes as follows:

> It is the feeling of fruit growers that many orchards in New York are fast approaching the (above described) conditions as evidenced by the poor physical condition of heavy soils and a gradual decrease in yields. Many such orchards have been given a new lease of life by the application of nitrogenous fertilizers, but it is a question as to how long the fertilizer effects will continue if, at the same time, no provision is made for additional organic matter.

Nevertheless sod, or even reduced cultivation, may not suit the requirements of individual growers for any tree fruit. A practice which is profitable in one locality may be less profitable or actually useless in another having different climatic or soil conditions. Consideration of the advantages and effects of each of these major systems (with modifications), upon the soil and the crop will assist the grower in choosing the soil-management program best fitted to his needs.

CLEAN CULTIVATION AND COVER CROPS

The more we cultivate, the greater the loss of structure in a soil, the less fertile it becomes, the more tillage it requires to maintain production, and the less effective tillage becomes.

A system of clean cultivation which does not include maintenance of organic matter is just as much a system of neglect as a sod system which neglects mulching, manuring, rodent control, and the like. Both are horticulturally unsound. In this discussion therefore it is assumed that clean cultivation as practised is rational and includes some or all of the following —cover and green-manure crop, farm manure, weeds, hay, straw, or other sources of organic material. In the absence of these, clean cultivation is simply asking for trouble, since it fails to replace the organic matter which it depletes.

What Cultivation Does—It removes noxious weeds; prevents weed competition for food and moisture during the most active vegetative period of the fruit tree; incorporates manures, including green crops, in the soil; prepares a seed bed for the next green-manure crop; and aids in the control of certain insect pests and mice.

Cultivation speeds up the decay of organic matter necessitating a strong replacement policy if the soil's productive capacity is to be maintained.

In many soils cultivation tends to the formation of a plow-sole, the compacting of the layer of soil just below tillage depth. This is most pronounced where the soil is cultivated while still too wet. To reduce plow-sole troubles in the early spring or after heavy rains cultivation might better be a day late rather than a day too early. Where a plow-sole condition already exists, deep tillage with a subsoiler (See Figs. 16 and 17), can often be done to advantage more especially in young orchards of restricted root range, or on land being prepared for planting. Plow-sole condition may correct itself if the land is left untilled as in sod.

Cultivation conserves moisture only in so far as it removes competing weeds or cover crops. Contrary to general belief, the cultivation of a weed- or plant-free soil does not conserve moisture in any appreciable degree.

Nor does it promote the upward movement of water from the subsoil, or distribution sideways. Frequent and deep stirring of soil may in fact speed up water losses by exposing fresh amounts of moist soil.

As to soil aeration, necessary in the release of plant food and in root development, the evidence indicates that sufficient aeration ordinarily takes place in orchard soils regardless of whether or not they are cultivated. In fact, the soil compaction which results from long-continued cultivation, inhibits aeration.

Time and Amount of Cultivation—As already noted, cultivation speeds up the decomposition of organic matter and the liberation of plant food. This speeding up of soil processes may be desirable for some conditions and crops, as for example vegetables, and undesirables or at least unnecessary and therefore wasteful for other crops and conditions. The grower should aim at the **minimum** cultivation which will serve his purpose thus lightening the burden of organic-matter maintenance. An additional advantage of shortening the tillage period is that two green-manure crops can be grown each season with corresponding increase of organic matter. However, young non-bearing trees may benefit from a longer tillage period since it prevents the competition of weeds or too-early-seeded cover crops. The older established, deep-rooted trees do not suffer from this competition.

At Vineland an experiment was started in 1928 in an eight-year-old apple orchard to determine whether or not cultivation could economically be reduced from the usual 2 to 3 months' period. The reduced or minimum cultivation consisted of simply plowing the land (fall or spring) followed by enough spring cultivation to prepare a seed bed. The green-manure crop was then sown, the whole operation usually being complete by May 15th. Normal cultivation was given to comparable plots which were seeded down about July 15th. Results for the nineteen-year period, 1928-47, are given in Table III.

TABLE III — A COMPARISON OF NORMAL AND MINIMUM ORCHARD CULTIVATION

(Accumulated yield in pounds per tree, 1928-47)

Variety	Normal Cultivation	Minimum Cultivation
McIntosh	4141 (21)*	4559 (19)
Baldwin	2123 (24)†	2080 (18)†
Northern Spy	4092 (18)	3621 (21)
Average —	3452 (63)	3420 (58)

* The number of trees for each variety and treatment is shown in brackets after the yield figures.

† Sixteen years only. The Baldwin trees were removed in 1944.

Up to the end of 1947 the McIntosh minimum cultivation outyielded the normal cultivation plots by about 10 per cent while the Northern Spy

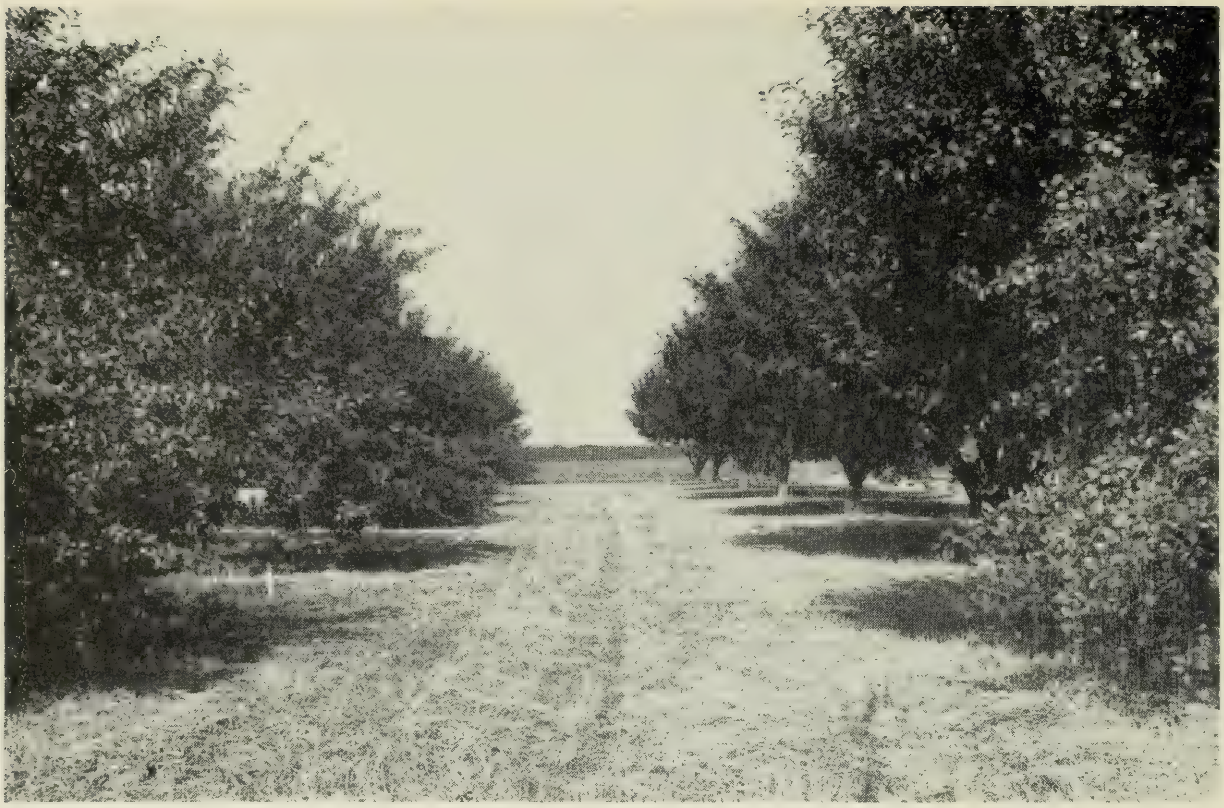

FIG. 9. **It is not necessary to always incorporate a green-manure crop. It may be mowed and allowed to remain on the surface, allowing for some second growth.**

normal plots have outyielded the minimum plots by 13 per cent. The Spy minimum plots are partly on eroded soil with consequent reduced vigour of some trees. Averaging all plots and varieties the two treatments, "minimum" and "normal" cultivation, are almost exactly equal in yield, indicating no benefit from the longer cultivation. Against it must be set the higher cultivation and organic-matter replacement costs of the normal plots.

As to time and amount of cultivation we may therefore conclude: Start cultivation as early as soil conditions permit to encourage a vigorous, early growth period. For Southern Ontario this may be as early as mid-April, and correspondingly later as one goes north. Discontinue early, even to the point, in apple orchards, of simply preparing for, and immediately seeding, a cover or green-manure crop. In any event discontinue after perhaps six weeks of cultivation, or not later than the middle of June (later farther north). A **light** late cultivation even as late as September, may be necessary to prepare for a late-seeded cover crop. For stone fruits, as peaches, cultivation may also be discontinued by mid-June or may safely and profitably be extended to the end of the month, the actual time varying with crop development, rainfall, or other seasonal conditions. As previously noted, young non-bearing trees benefit from proportionately longer cultivation.

Depth of Cultivation—This involves plowing, disking, harrowing. We have been brought up to believe that plowing is an almost indispensable soil treatment possessing many virtues. More recent opinion strongly suggests that we have been doing much unnecessary work, even actually harmful in its effects on both soil and tree. Without attempting to analyze the varying opinions it may be said that real virtue lies in the shallowest cultivation which will accomplish the desired result. If soil type and the

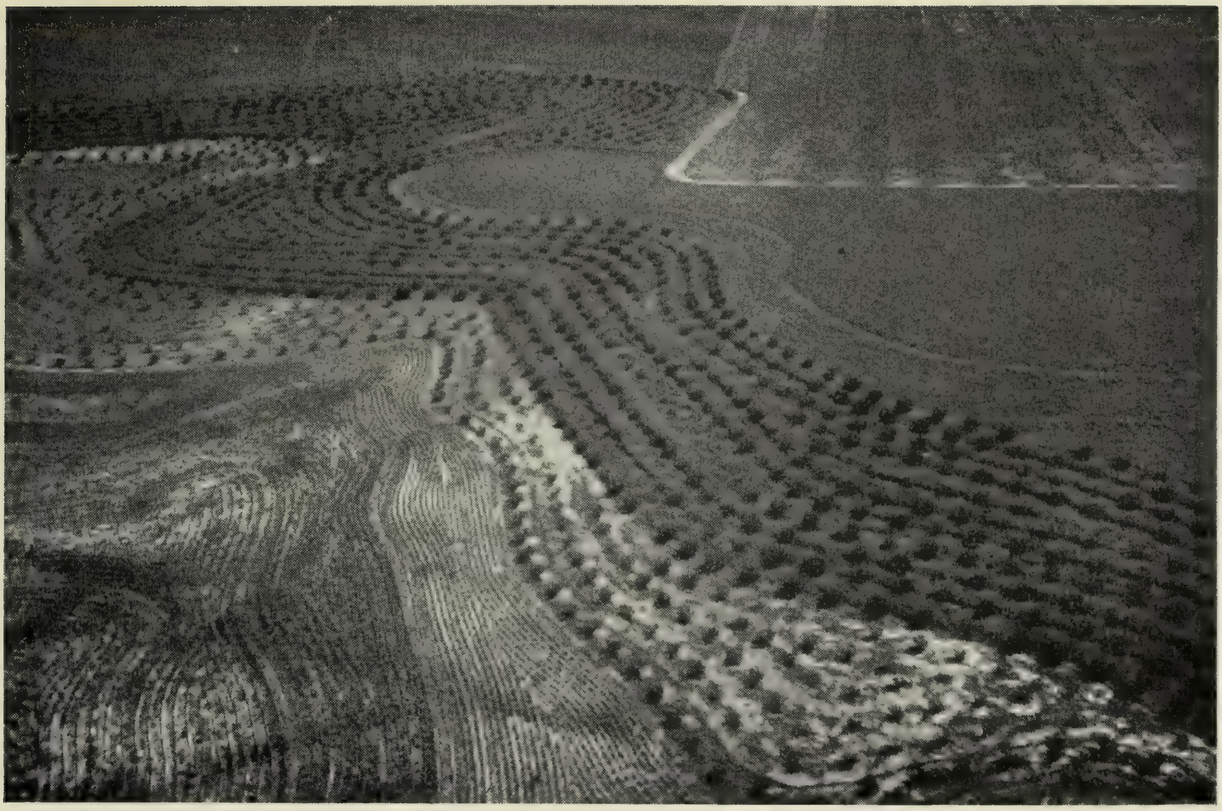

FIG. 10. A South Carolina peach orchard planted on the contour to prevent erosion and loss of soil fertility. (Photo, courtesy South Carolina Extension Service.)

amount and nature of the manuring material to be incorporated in the soil permit of disking rather than plowing, then disking it should be. If later cultivations can be satisfactorily done with shallower implements than the disk, then they should be used. Don't worry if some trash is left on the surface or only partially buried. While it may offend the eye it will please the tree. It's just another case of minimum rather than maximum cultivation. Many Niagara Peninsula orchards, so-called peach soils, are now handled without ever using a plow, and are the better for it.

Contour Cultivation—Soil erosion is an increasingly serious orchard problem, even on only moderately rolling land. The grower should then consider contour furrowing, or plowing and planting land across the slope instead of in straight rows regardless of slope. Terracing is a type of contour cultivation. The essential consideration is to set up natural controls so that water will be conducted off at low velocity thus greatly reducing or entirely preventing erosion. In planting an orchard on the contour plan, the contour of the land, including all its irregularities, must be followed closely so that there is not more than 2 per cent deviation in any 100 feet. This may require the services of a land surveyor in staking out an orchard site of any considerable area.

Intercropping—During the early years of the young orchard, it is common practice to intercrop. The ultimate well-being of the orchard must, however, be the first consideration, and intercrops should therefore be chosen carefully and discontinued early. Preference should be given to crops requiring early summer cultivation such as peas, beans, tomatoes, early potatoes, strawberries. Bush fruits are likely to be left too long for the good of the orchard. Whatever the crop, special care should be taken to avoid undue competition with the orchard by leaving a crop-free area around each tree, enlarging this area as the tree increases in size.

Choice of intercrop for the cherry and the peach should be made with care. Potatoes, tomatoes, and raspberries are subject to verticillium wilt, a soil-borne disease, and it is now known that cherry and peach orchards planted on former sites of these three crops, are subject to this disease. Limbs, and often the entire tree, become affected, frequently causing severe loss.

Rotation of Green-Manure Crops—Continuous use of buckwheat year after year as a green-manuring crop may lead to a loss in desirable soil structure. Some recent Vineland work from a ten-year experiment with organic-matter residues shows that the "buckwheat only" plots had the greatest volume weight per cubic foot of soil, the least non-capillary porosity, and the greatest dispersion ratio. This simply means the soil from these plots was denser, had less air space, and dispersed or "puddled" faster during rain than soil under other crop treatments. A green-manuring system using several crops in rotation would prevent a recurrence of the buckwheat result. This does not mean that buckwheat cannot be used, but that it should be used in a rotation with other crops. Suitable crops would include annual sweet clover, Italian rye grass, millets, mixed grains, rye and vetch mixed, soybeans, sweet clover.

It is not known whether some other green-manure crops, used alone continuously for long periods, may not have deleterious soil effects either similar to buckwheat, or in other ways. In any event, in the absence of specific knowledge, it is recommended that green-manuring crops be varied from time to time using several or all of those noted above, in rotation.

Rotation in the Use of Manures and Fertilizers—Orchard needs may call for annual applications of both manure and fertilizers, plus the growing of green-manure crops. The severe winter freeze of 1942-43 was a good, if costly demonstration of the importance of good fertility; for example peach orchards well fertilized and well supplied with organic matter, whether annually or in rotation, came through with less tree injury and greater crops than neighbouring orchards.

However, whether from financial or other reasons, the grower may not always be able to make annual and substantial applications of manure and fertilizers. He will be inclined to make a little fertilizer go a long way spreading it thinly over a large acreage when it should perhaps be concentrated on a smaller acreage under a system of rotating applications over a period of years.

Mineral fertilizers applied in small amounts are ineffective because soil fixation ties up too much of the light application in an unavailable form, leaving insufficient for the trees. Also manure applied in too light amounts (5 to 6 tons per acre) does not benefit the trees as much as when put on in moderate applications of 10 to 15 tons annually or in rotation as suggested. An economical rotation is to apply manure one year, minerals the next, and hay or straw supplements the third, with a green-manure crop every year. Such a rotation would assure adequate applications.

SOD CULTURE

Definition of Terms—"Sod" means various things to various people. As used here, sod, sod neglect, and sod mulch may be defined as follows:—

Sod—a cover of grasses, legumes, or mixtures, fertilized with sufficient nitrogen to maintain good growth of cover and adequate tree growth and foliage colour, cut when required, remaining where it falls.

Sod Neglect—a cover of grasses, legumes, or mixtures, usually not cut more than once each season, and usually taken off as hay. Seldom, if ever, fertilized with additional nitrogen or manure. Tree growth and yield insufficient for profitable operation.

Sod Mulch—a cover of grasses, legumes, or mixtures, cut as required, and the cut material drawn under the trees. Additional hay or straw is frequently brought in from outside the orchard to supplement the mulch under the trees. Some growers prefer to leave the cut covers where they fall and rely entirely on outside material to build up the layer of mulch under the tree. Nitrogen fertilizers are applied, if required, to maintain good growth of cover and tree, and good foliage colour.

As compared with clean cultivation a well-managed sod culture or mulch system for apple orcharding has been shown by grower experience and experimental evidence to accomplish certain results. In the early years tree growth and yield under sod mulch will lag somewhat, but will catch up in 10 to 15 years and may eventually surpass clean-cultivated trees. Fruit size, under sod mulch, will be equal or superior to clean cultivation, colour will be better, date of maturity will be earlier, "drops" will suffer less injury from bruising, soil fertility will be superior, orchard operations as pruning, spraying, harvesting will be facilitated due to firmer footing at all times. Supporting evidence is given for these statements.

Note the term "sod culture". Sod "neglect" has no place in successful orchard management, but unfortunately it was the neglected sod orchard which formerly brought sod into disrepute. The sod was simply evidence of lack of grower interest. Mostly the orchards were small and a bit of a nuisance. Then there were revival meetings throughout Ontario and growers were encouraged to prune, spray, fertilize, **and cultivate**. This cultivation,—breaking up of long-established sods—released unusual quantities of plant food which, with heavy pruning, caused a sudden surge of growth and fruitfulness. Seemingly the superiority of cultivation over sod was established, but the early treatment had been sod neglect not sod culture; and in any event continued cultivation, unless accompanied by manuring, would soon deplete the organic matter which had accumulated under sod conditions. Growth and fruitfulness must eventually decline.

A permanent sod-culture system, in the light of present knowledge, is suited only to apples, pears, and sweet cherries. Accompanying discussion therefore concerns these fruits, and more particularly the apple itself. In many apple producing areas in Canada, as elsewhere, sod culture has come into wide favour due to its demonstrated advantages.

When to Start Sod—Some growers prefer to till the young orchard until bearing age is reached and then seed down, and this may have advantages where erosion is not a problem but certain insects are, as for example the Buffalo tree hopper. This insect can be quite troublesome.

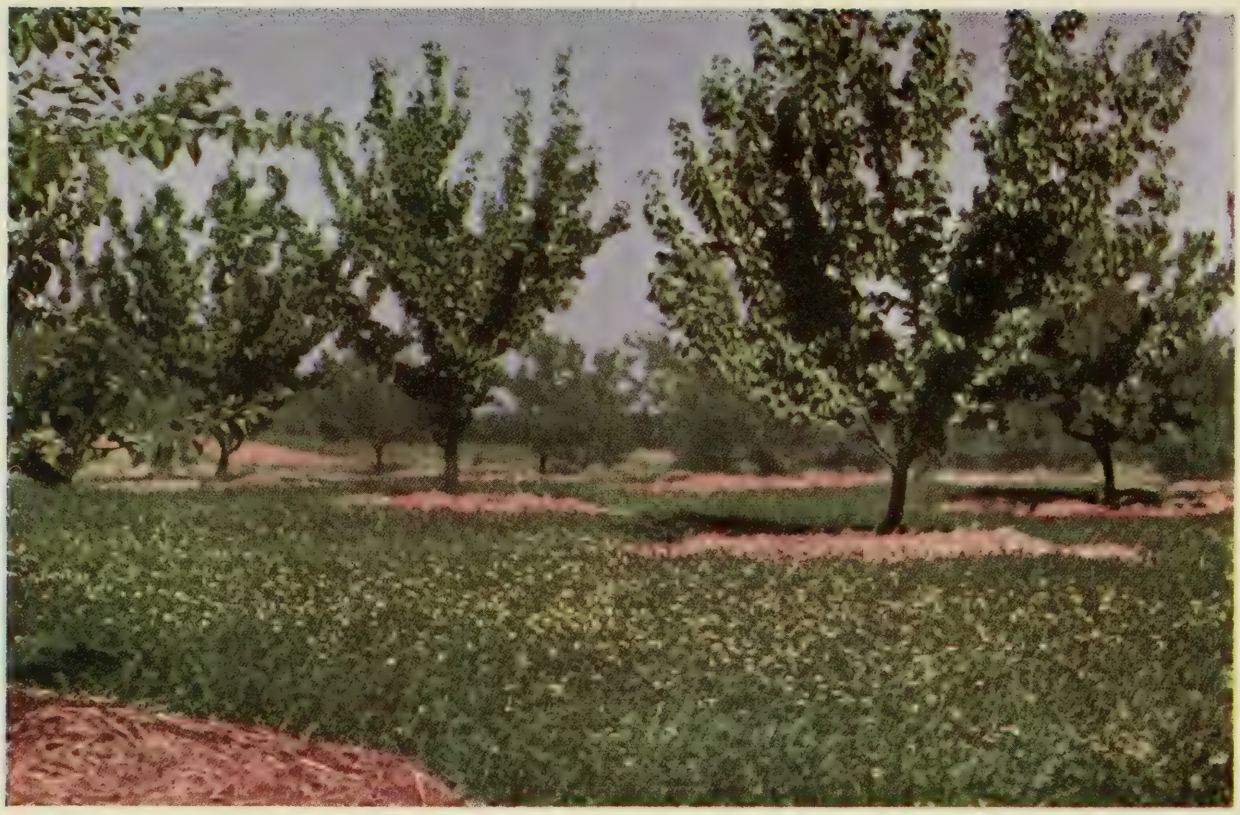

FIG. 11. A good stand of Ladino clover in a mulched apricot orchard.

Michigan authorities, (Special Bulletin 313), reporting on an experiment at their Graham (Grand Rapids) Station, comment as follows:

> Commercial apple growers, almost exclusively, follow the practice of maintaining their newly set orchards under the cultivation-cover-crop system of soil management, until such time that it appears the trees are sufficiently well established to withstand the competitive influence of a grass sod. Opinions of these growers however, differ as to when this period has been reached. Some hesitate to change over to the sod-mulch system before the trees reach the age of 20 or 25 years, while others seed their orchard to grass at an earlier age. In view of the data presented on the growth and yield of the trees in this experiment, it appears entirely feasible that the sod can be established at a much earlier stage than was formerly thought advisable, without appreciably changing the rate of tree growth and fruit production. It is believed that the value of the somewhat greater growth and yields obtained in the young orchard under the clean culture system, by delaying the change-over to the sod-mulch system, will not equal the value of the additional soil and fertility lost during the same period by erosion, particularly on erosive soils and steep slopes. Tree growth can be increased, in a large measure, by applications of the necessary fertilizer elements, but the cost of replacing the lost soil with its humus and fertility in the orchard, will much exceed the value of any extra fruit produced. The more erosive the soil type and the steeper the slope, the earlier is the date at which the cultivated orchard should be seeded down to grass.

At Vineland, our own experience with a 4½ acre block of McIntosh has been that, with necessary attention to mulching (including additional material if needed) and fertility, sod may be started at the time the orchard is planted, or within a year or two. However, growers may prefer to cultivate and intercrop for a period of years before seeding down.

The results in this McIntosh orchard are given in Table IV. The orchard was planted in 1922, the initial sod plots were seeded in 1923 and the delayed sod plots in 1928.

TABLE IV — McINTOSH YIELDS UNDER DIFFERENT SOIL TREATMENTS

Treatment	Number of trees	Accumulated Yield per tree 1922-1940
Cultivation and cover crops throughout, 1922-1940*	15	1,966 lb.
Grass sod mulch throughout, with nitrogen as required, 1923-1940	19	1,998 lb.
Alfalfa sod mulch throughout, 1923-1940	30	2,287 lb.
Cultivation 6 years (to 1927) then alfalfa sod-mulch 1928-1940	15	2,329 lb.
Cultivation 6 years (to 1927) then grass sod-mulch 1928-1940	30	2,293 lb.

*Sown July 15th.

Grass and alfalfa sod mulches throughout the life of the orchard have equalled in yield cultivation throughout for the fifteen crop years, and in the light of other evidence (Michigan, Pennsylvania), might be expected to eventually outyield cultivation. Delaying the establishment of the sod for six years has given some increased yield for a grass sod, but none in the case of alfalfa.

The "Mulch" in Sod Culture—Sod culture normally implies that the sod material, grass or alfalfa, will be cut as necessary, during the growing season, the cut material either being left where it falls or concentrated as a mulch under the tree. Nothing is removed from the orchard. It is not a hayfield. The mulch in fact is an integral part of the system. Additional material, strawy manure, straw, old hay, or other crop refuse may be drawn in to supplement this mulch and build it up sufficiently to practically smother growth under the trees. If tree growth and fruitfulness fall short of requirements, farm manure or fertilizers, or both may be added as needed.

Michigan investigators have estimated the annual cost of maintaining the mulch system at $4.50 per acre, this figure including the expense of mowing, raking, and spreading under the trees. Where additional material, calculated at two tons per acre, is needed to supplement the sod cuttings the cost rises to $10.25 per acre. This compares with $10.60 as the estimated cost of cultivation plus cover-crop management.

As noted, during the active tree-growing period the grass or alfalfa sod should be cut, to minimize moisture competition with the tree. When the cut material is used as a mulch it should be spread under the trees immediately, starting a foot or two from the trunk (as a measure in mouse control) and extending to, or somewhat beyond the spread of the branches. The amount of mulch, whether or not supplemented by additional material, should be sufficient so that, while fairly well decomposed by the latter part of the season it is still heavy enough to retard most grass or other growth under the trees.

Where alfalfa is the sod crop and the cut material is used as a mulch around the tree, supplemented by other leguminous material from outside the orchard, the decomposition of this material will add considerable fertility. While the orchard is young this stimulation encourages quick estab-

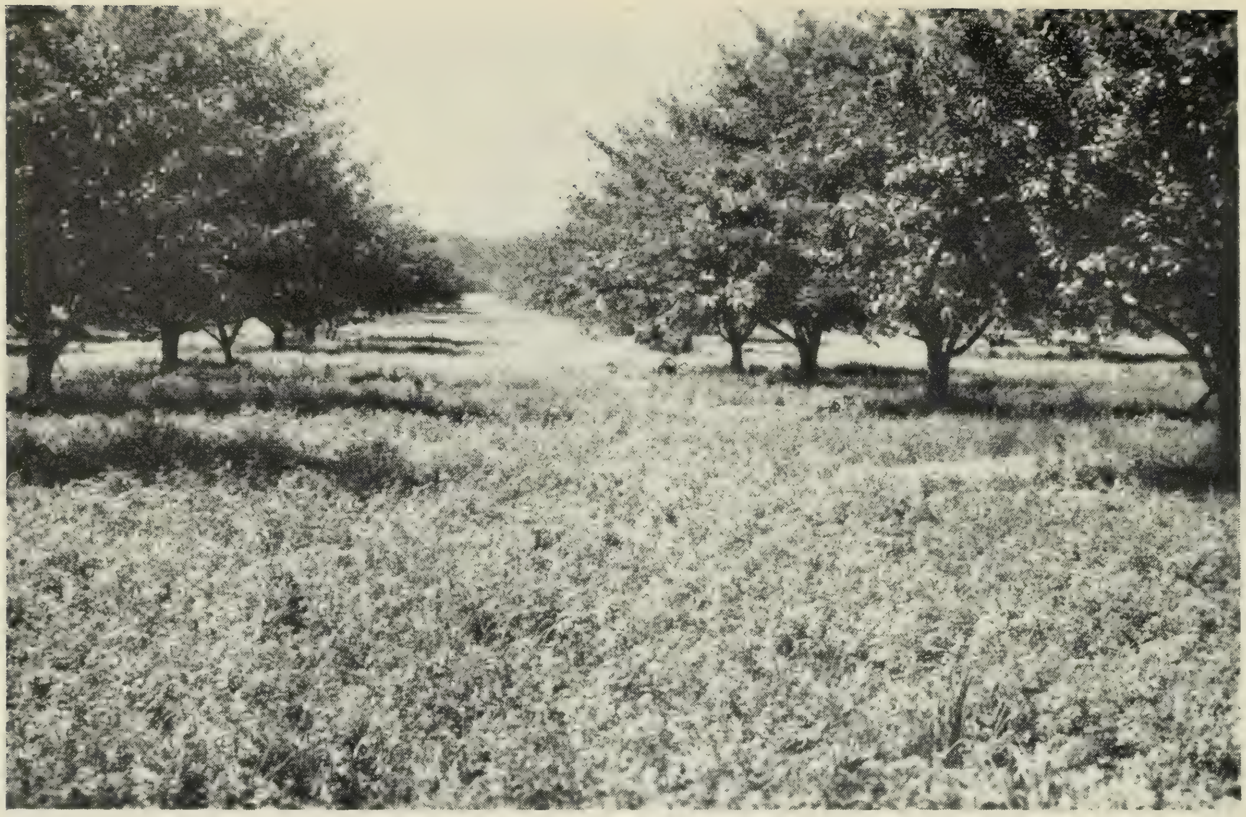

FIG. 12. Alfalfa sod mulch in an apple orchard. The alfalfa will be mowed during the season, the cut material mulched under the trees, and supplemented if necessary.

lishment of the tree and rapid development of the framework. However, as the tree comes into bearing and as the mulched area increases, if all the material applied is of a leguminous nature, too much nitrogen may be liberated from the mulch. This nitrogen over-stimulation may be sufficient to throw the mature trees from a fruitful into an over-vegetative condition. Therefore, when large amounts of material are required to maintain the mulch under the tree, it is recommended that some of the addition to a legume sod be non-leguminous in character. It may even be stated that where mature apple and sweet cherry trees are making more than fifteen inches of terminal growth annually all mulch additions could be non-leguminous; and conversely that where the growth is less than eight inches annually a legume could be used to advantage.

Effect of Mulch on Soil Fertility—One effect of decaying organic matter is well illustrated by some Ohio results reported in **Science** (December 10, 1937) under the title, **The Potassium Content of Soil Beneath a Straw Mulch**. In the Experiment Station Orchards at Wooster, it was found that, on the whole, potassium was very low. When potash salts were applied, the potassium was "fixed" in the surface soil and failed to move downward into the root zone even after ten years of treatment. Part of their orchards were under a mulch system of management and they were interested to know to what extent potassium had accumulated under this mulch from the decomposing straw. Their findings were as follows:

> These quantitative results show conclusively that potassium is very high to a depth of from 24 to 32 inches and sometimes to 40 inches beneath the 38 year old mulch. This is highly significant in the light of the characteristic fixation of potash salts in the surface inch and a-half to two inches of surface soil. In no case was potash fertilizer applied to the mulch trees.

> Samples of soil taken from the grass area between the trees showed no such accumulation of available potassium. Those taken from an adjacent unfertilized plot which has been in a three-year rotation of potatoes, wheat and clover showed a very low potassium content even in the first few inches of topsoil.
>
> Another orchard nearby which has been in different systems for twenty-two years shows similar results. The soil under the mulched trees has a high available potassium content to the depth of the rooting area of the trees, while the soil under the trees kept in the tillage-cover crop system is very low in this element. For example, the soil beneath two trees in the mulch system has a content of 1,000 pounds per acre of available potassium at the depth of 24 inches, while the soil beneath a tree 40 feet away in cultivation contained less than 175 pounds at the same depth.

In a later (1943) report on this Ohio orchard it was found that all the elements investigated (potassium, calcium, magnesium, phosphorus, boron) had been increased in the soil beneath a heavy mulch as compared with adjacent land under cultivation. Potassium was considerably increased under mulch at all depths sampled. A smaller effect was noted on calcium and magnesium. The increases in phosphorus, boron, and organic matter were confined to the area just beneath the mulch.

Similar evidence was secured from a block of apples at Vineland, planted in 1924, seeded to alfalfa in 1932 and the cut alfalfa mulched under the trees thereafter. Analysis of soil samples taken in July 1936, (a very dry summer), both from under the mulch and from adjacent areas of growing alfalfa between the trees, gave the following nutrient levels.

TABLE V — NUTRIENT LEVELS UNDER ALFALFA MULCH AND IN THE OPEN

	Potassium	Phosphorus	Nitrate	Per Cent Moisture
Under Mulch				
0-6″ depth	50 p.p.m.*	High	313 p.p.m.	10.9
6-12″ depth	20 p.p.m.	High +	137 p.p.m.	8.8
12-18″ depth	20 p.p.m.	Very High	95 p.p.m.	4.9
Between Trees				
0-6″ depth	15 p.p.m.	High	55 p.p.m.	5.7
6-12″ depth	5 p.p.m.	High +	28 p.p.m.	6.8
12-18″ depth	5 p.p.m.	Very High	22 p.p.m.	4.5

* p.p.m. is simply "parts per million", the way in which the soil chemist expresses the amount present of a given plant food.

Potassium, nitrate, and moisture were considerably higher under this **alfalfa** mulch than in the adjacent area between trees, while phosphorus did not vary. Nutrient levels, nitrogen particularly, would not be so high under a non-legume mulch, or in seasons of heavier rainfall.

Existing orchards on shallow soils can be greatly improved by the adoption of a mulch system. As pointed out above, the nutrient level rises due to the mulch, moisture conditions are improved, and eventually, after the mulch has become established, soil structure will improve. Cultivation, even the shallow cultivation now recommended and practised, discourages root activity in the surface zone of the soil. On the other hand, mulches encourage root formation near the surface, in fact roots grow right in the mulch material. Mulch on shallow soils therefore increases the effective feeding area, with improved tree performance.

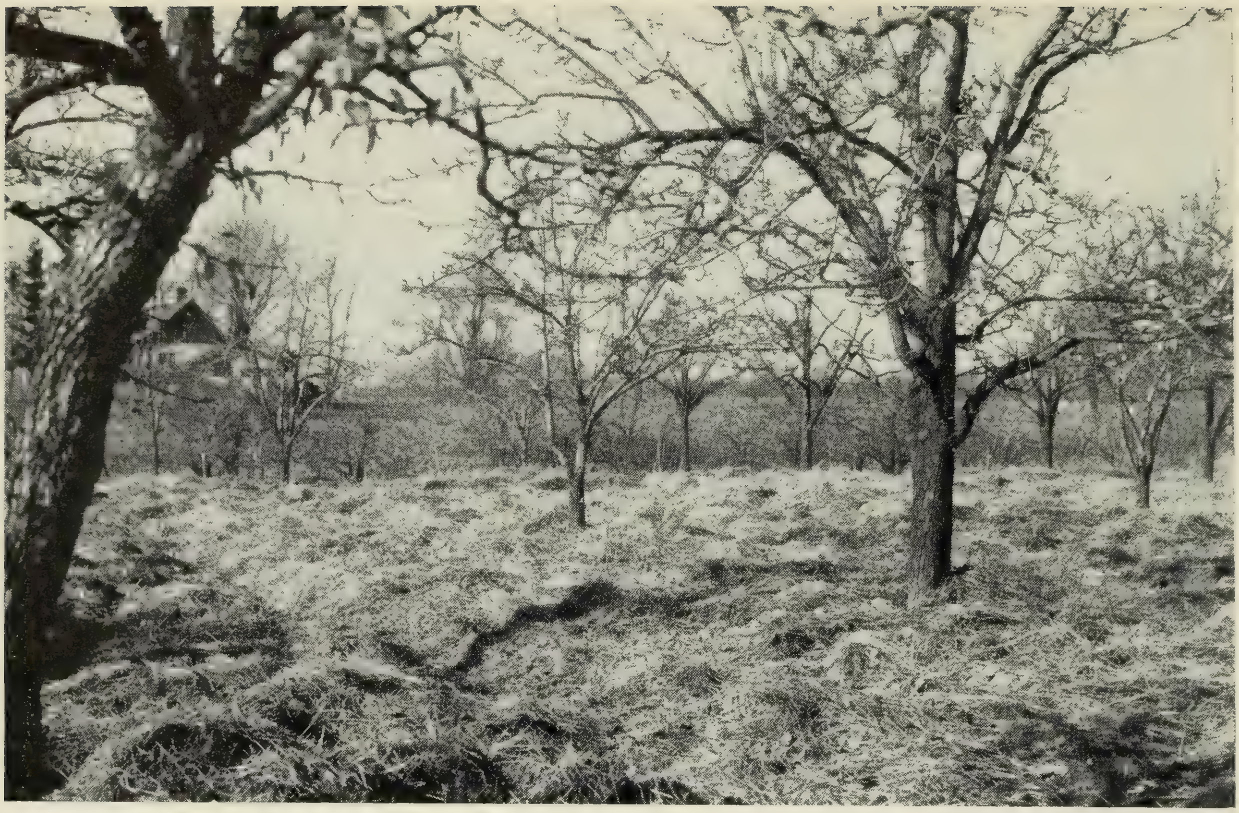

FIG. 13. Worn-out cultivated soils can be greatly and quickly helped by a mulch of old hay or other crop refuse.

Effect of Mulch on Soil Moisture—Table V indicates (last column) that, at Vineland, soil moisture was higher under mulch than in adjacent unmulched sod areas. Also workers in Ohio, Pennsylvania, Massachusetts and Michigan report an increase of soil-moisture under sod mulch as compared with clean cultivation. Michigan results, for example, show that in a Duchess-Northern Spy orchard the average soil-moisture content during August, September and October was 47 per cent higher for the sod mulch. In commenting on this in Michigan Special Bulletin 313, the author writes:

> The greater soil moisture in the sod-mulch plots can partially be attributed to the two soil coverings—namely, sod and mulch. These naturally slow down any movement of surface water, thereby increasing the time during which the water may penetrate the surface soil. Further, the soil under sod and protective mulches, is much more porous, which accelerates the movement of rain or snow water into the soil. In contrast, the clean-cultivated soil offers little or no resistance to the escape of precipitation water. Its less porous condition, brought about by a lower humus content, compacting by heavy orchard equipment, and the beating down and puddling of the surface by dashing rains greatly retards the free penetration of snow and rain water. Also, it has been observed that the soil in the cultivated plots froze at an earlier date and to a greater depth than it did under the protective covers of sod growth or mulch. Consequently, the longer period of frost in the soil of the cultivated plots would retard the free downward movement of water over a longer period of time than the less frozen soil in the sod-mulch plots.

Effect of Sod and Mulch on Microfloral Activity—At the present time little is known of the relative effects of sods, mulches, and clean cultivation on soil microflora populations. Observed beneficial effects on trees grown in sod, sod mulch, or mulch alone, as compared with clean cultivation seem to have been out of all proportion to either the fertilizing value of the material, or to its moisture-holding capacity. Just how far this result may be co-ordinated with a stimulation to, or even a change in type of, the microflora in the soil is now the subject of new studies at Vineland. In the light of the increased accumulation of nitrate under mulch reported by Beaumont and Crooks, (Soil Science, 36:1, 1933) and similar findings in Vineland soils, it is interesting to note that, in these new studies, the preliminary bacteriological examination so far has indicated an increased activity of the nitrifying organisms under mulch. Thus it may well be the case that predominating microfloral types under a sod or mulch are substantially different and horticulturally more desirable than under clean cultivation. Also, it may be the case that certain microfloral populations now held in check by clean-cultivation conditions are capable of much greater activity under a permanent cover, with, or without a mulch.

The Effect of Sod and Mulch on the Fruit (Apple)—It is common observation that sod (unmulched) apples are of higher colour and firmer, crisper texture than cultivated ones. Where the sod becomes a proper mulch system, the fruit tends to become more like cultivated fruit, depending upon the nature, amount, and continuity of the mulch, but is still superior in colour and firmness, unless an over-abundant legume mulch is maintained. Sod-mulch fruit matures earlier than cultivated, yet nevertheless, holds better to the tree, especially noticeable in McIntosh. Early dropping of McIntosh is associated with nitrogen availability, being less severe where there is comparative nitrogen starvation in the latter part of the season as under a moderate to light mulch, or reduced cultivation, or sod "neglect".

In recording the relative effects of sod mulch and cultivation on fruit size (apple) a Michigan investigation notes the following results over an eight-year period for Duchess, Grimes Golden, Baldwin, Stayman Winesap.

TABLE VI — COMPARATIVE SIZE OF CULTIVATED AND SOD-MULCH APPLES

Soil Treatment	Grade Sizes	Average Yield Apples for all 4 varieties
Cultivated	2½″ up	47.1 per cent
	2¼″ — 2½″	36.9 per cent
	2 ″ — 2¼″	15.9 per cent
Sod Mulch	2½″ up	84.2 per cent
	2¼″ — 2½″	13.7 per cent
	2 ″ — 2¼″	2.0 per cent

Contrary to general belief the sod-mulch apples averaged larger than the cultivated ones. This is not uncommon where a proper mulch system is followed, and in fact oversize fruit may **sometimes** become a problem due to exceptionally favourable moisture and nutrient conditions induced by the decomposing mulch. In such event the grower should, temporarily at least, discontinue mulching under the trees, but cut the alfalfa or grass as required and let it remain where it falls.

Effect of Sod and Mulch on Yield—Table IV (page 37), used in the discussion on the time of establishing the sod, shows also that total yield is not adversely affected by the sod mulch. In fact these Vineland sod plots, whether established when the orchard was planted, or six years later, either equalled or surpassed the yield of the cultivated plots. Michigan results were similar as indicated in Special Bulletin 313.

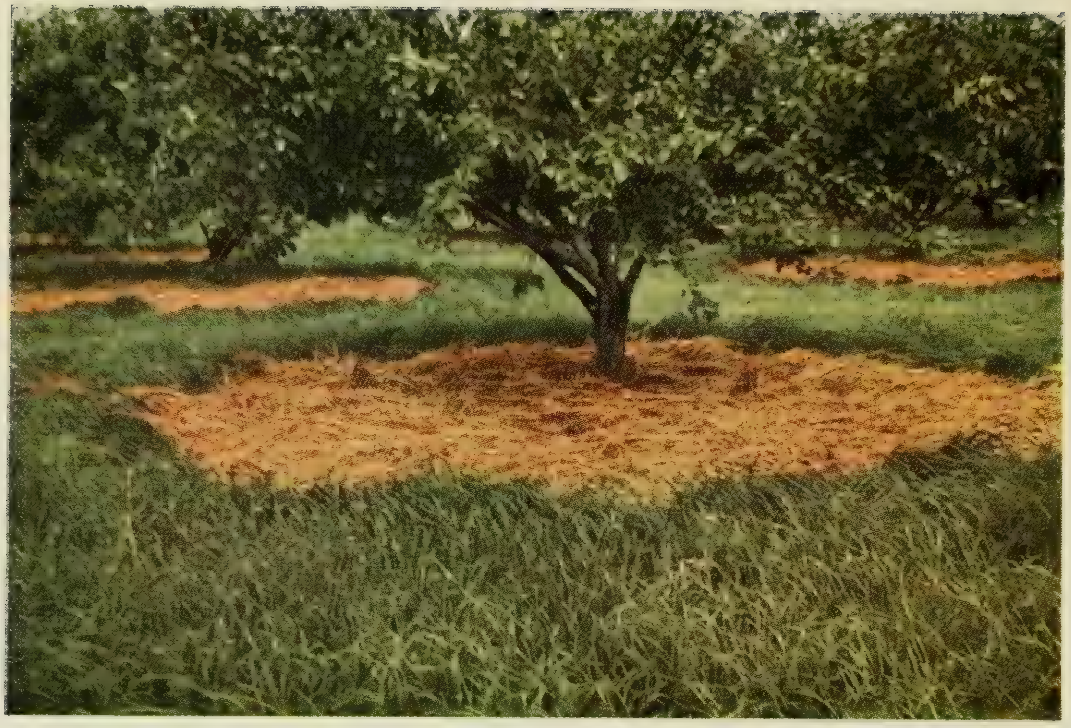

FIG. 14. Sod mulch—a system well suited to apple, pear, and sweet cherry. The tree thrives, the soil improves, there is no erosion.

> . . . the trees under clean cultivation . . . showed a greater yield for the first 10-year period than the trees growing in sod-mulch plots. However, by the end of the 15-year period the total production for all (five) varieties in the sod-mulch plots, except Duchess, was greater per acre than for the trees in the cultivated plots. This was also true of the 20-year period when all of the trees grown in sod, including Duchess, showed heavier total production of fruit than the cultivated trees.

On a percentage basis, the increased sod-mulch yields (over cultivation) for the 20-year period were, Duchess 7.4, Grimes Golden 15, Baldwin 42, Stayman 32, Northern Spy 86.

Fertilizer Needs of Sod Mulch—Before establishing a mulch a soil test should be made to determine the mineral levels of the soil. If there is a mineral deficiency this should be corrected before the mulch is put down. Applying fertilizer on top of the mulch will not be as effective because it may not percolate to the soil level where the deficiency exists; and additionally it may lead to considerable fixation of the minerals through exposure to varying air temperatures and moisture supply. Normal nitrogen applications for the tree may be made on the mulch because nitrogen is soluble and will penetrate with rain. Under ordinary conditions extra nitrogen to decompose the mulch is not necessary as normal applications for the tree will take care of both tree and mulch. In any case, it is not desirable to have too rapid decomposition of the mulch take place. The main value of the mulch is not so much in plant food released by decomposition as it is in improving the physical condition of the soil, its moisture-holding capacity, increasing desirable soil organisms, and perhaps preventing too-high soil temperatures.

Where legume hay is used for the mulch the amount of nitrogen for the tree may need to be reduced, (see The "Mulch" in Sod Culture, page 37), while the sod between the rows may require the regular amount.

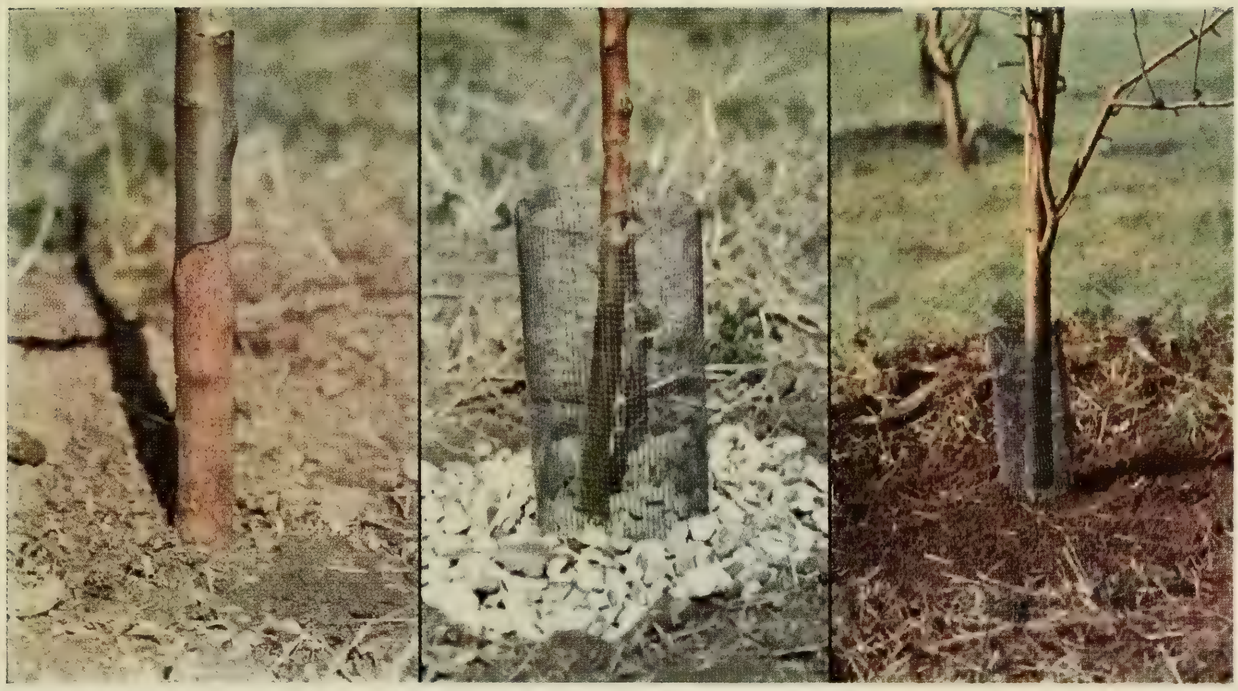

FIG. 15. Protect your trees from mouse injury. Left—Mouse injury on unprotected tree. This tree can be saved by bridge grafting, but it is a costly operation. Centre—Crushed stone, preferably a smaller size than shown, prevents mice from burrowing under the guard. Right—In mulched orchards, lacking stone, the mulch should be kept away from the tree-guard to discourage mice from burrowing under it.

Fertilizer Needs of Unmulched Sods—Mention has been made that, in the past, much of the adverse effects from sod without mulch have been due to a "neglect" program (see Sod Culture, page 35). For some fruits, sod alone, if properly handled and adequately fertilized, can be a good orchard practice. After an unmulched sod becomes well established, nitrogen fertilizers should be used for both tree and sod. To insure the tree receiving its share of the nitrogen it is advisable to fertilize in the fall, when the sod is relatively inactive. Experimental work has shown that, where trees under sod conditions require nitrogen stimulation, the application of nitrogen in a ring just under the outer spread of the branches is more effective than a broadcast application over the entire tree area. However, it should not be overlooked that the sod cover between the trees may also need nitrogen and a supplemental broadcast for the cover only should be made. (For use of manure on sod see Farm Manure, page 22.)

Specific rates of application of nitrogen fertilizers on unmulched sod are difficult to define because of varying conditions—age of tree, amount of growth, type of cover, other fertilizer applied, all entering into the picture. In general, the application should be twice the recommended amount for clean-cultivated orchards (see Nitrogen Applications, page 46). Again, it should be emphasized that to be successful, an unmulched sod must be adequately supplied with nitrogen.

Mulch and Mice—A mulch under trees provides ideal conditions for mice. Since they prefer not to feed or travel in the open, a circle about three feet in diameter should be kept bare of mulching or other material. Quarter-inch mesh galvanized wire guards provide an economical permanent protection against mice. In addition poison bait should be set out every fall to eradicate any mice that may have become established.

RELATIVE SUITABILITY OF CLEAN-CULTIVATION, SOD, AND SOD-MULCH SYSTEMS FOR VARIOUS FRUITS

From the discussion thus far, it may be accepted that, while a given system of soil management may be the most suitable for reducing water run-off and erosion, and maintaining fertility, yet it may not be entirely satisfactory for certain fruits. Thus sod mulch succeeds well with apples where soil and climatic conditions are favourable but has yet to be proven equally suitable for peaches, plums, or sour cherries. For these fruits the answer may lie in restricting plantings to favourable soils and locations, growing cover and green-manure crops, and practising shallow and short-time cultivation so that much of the plant material remains on or near the surface.

The recommendation then, is to consider sod mulch, or certainly reduced cultivation, for apples, pears, sweet cherries, not only on rolling land subject to erosion, but wherever conditions seem to warrant. For the stone fruits, peaches, plums, sour cherries, continue clean cultivation and green manuring, plus farm manure if available, but reduce the kind and amount of cultivation to the minimum which the individual grower finds from experience will sufficiently maintain growth and yield under his conditions and leave his soil unimpaired or even improved. No rule of thumb can be given as no two fields are entirely alike due to differences in treatment and cropping of earlier years. Factors which must be considered are, amount and distribution of rainfall, soil type and present fertility, the price of manure or substitutes and the ease with which they may be secured, the value of the fruit crop, etc. The grower, too, must be susceptible to new ideas.

It is worth while at this point to record the results of a survey of grower experience and experimental evidence relating to modified cultural practices for peach orchards, made by Bregger and Musser of South Carolina. They conclude as follows,—

> In spite of the almost universal acceptance of the traditional cultivation systems for peach orchards, evidence has been piling up which indicates that certain conservation practices, including continuous vegetative and mulch covers, modified sod, or simply a short annual period of cultivation, are both practical and successful. The authors of this paper are presenting the experiences of various growers, especially pertaining to orchard soil management practices which completely or largely eliminate cultivation. These changes in practice toward the adoption of unorthodox measures have often been brought about by grim necessity, due to severe erosion with an accompanied low state of tree vigor.
>
> The "cover" practices which are being used to replace the traditional clean-cultivation with or without planted cover crops may be divided roughly into two groups (1) continuous grass or legume sods, either solid or broken into strips, and (2) mulches. Other modifications include curtailment of the intensity or length of the cultivation period, the use of "trashy cultivation" where cover crop residues are left on the surface, and even the reseeding of cover crops without cultivation.
>
> Solid sod covers have been quite successful in several Michigan and Pennsylvania peach orchards where planting was done on deep soils. Harry Skinner and Clayton Miller, well known orchardists, near Chambersburg, Pa., have for many years used sweet clover as a peach orchard cover crop with only early spring cultivation, being careful to mow the cover crop at other critical periods. In a field test near York, Pa., peach trees were also seen making a good growth in mixed covers of orchard grass, clover, and Korean lespedeza.

SOIL TESTING

Information from soil tests, carefully made and properly interpreted, provides the grower with a statement of his soil's fertility and indicates what, if anything, is needed to balance the plant food already present and maintain the soil in a high state of fertility. The grower is then better able to regulate his system of soil management by more intelligent use of fertilizers, manures, and green crops.

Soil chemistry has now reached the point where it is possible to make rapid soil tests with reasonable accuracy. If the samples are carefully taken, and enough of them are mixed in a composite sample to accurately represent the orchard condition, the rapid soil test will give a fairly reliable picture of the soil's fertility. The tests usually made comprise acidity (pH), nitrate, phosphate, potash, and lime.

Soil acidity can play a very important part in the behaviour of the orchard. Too great an acidity or too much alkalinity will interfere with the nutrient intake of the tree and cause poor growth and fruitfulness. The tree fruits respond well in a soil having an acidity of around pH 6.0 to 6.5 but may begin to show nutritional troubles above and below this range. The lime or calcium test gives an accurate picture of the available calcium in the soil. Even in an acid soil available calcium is necessary, not only to lessen acidity, but to feed the plant. Nevertheless, the **indiscriminate** application of lime to an orchard soil should be discouraged, as harm may be done if the soil is already at, or above, the neutral point.

The nitrate test is significant only for the particular time of sampling, since soil nitrates fluctuate from season to season and even from day to day depending on moisture, temperature, and growing conditions. A more accurate indication of the need for nitrates (nitrogen) is the pale colour of the foliage, the reddish colour of the bark on the tree, and the shortness of the terminal growth.

The phosphate and potash levels shown by the rapid tests are an indication of the available phosphate and potash supplies in the soil. A low test indicates a deficiency which can usually be corrected by appropriate fertilizer applications. For detailed recommendations as to kind, amount, and manner of application of commercial fertilizers (based on normal peacetime supplies) the grower is referred to Ontario Department of Agriculture pamphlet, **"Recommendations for Soil Management and Use of Fertilizers"**.

To be of value in diagnosing crop needs, the soil samples submitted for analysis must be representative of the orchard and must therefore be carefully collected and prepared, and should be taken during the active growing season, May to October. To this end detailed instructions, available on request, may be secured either from the Horticultural Experiment Station, Vineland, or the Department of Horticulture, O. A. College, Guelph.

FERTILIZER USAGE

More detailed recommendations on fertilizer usage than it is possible to include here, are given in Ontario Department of Agriculture pamphlet **"Recommendations for Soil Management and Use of Fertilizers".**

NITROGEN FERTILIZERS

In orchard work, time and method of application practically require that the nitrogen be applied separately from the minerals. Whether or not nitrogen should be applied to tree fruits, and in what quantity, will depend primarily on the age and condition of the trees, whether cultivated or sod, the nature of the sod (legume or non-legume), and the present mineral content of the soil. Nitrogen applications to a low-mineral-content soil are likely to be harmful rather than beneficial. Nevertheless most **bearing** orchards require nitrogen. Apply as needed and in the form preferred by the grower. On alkaline soils, a nitrogen fertilizer with acid reaction, such as ammonium sulphate, should be used.

To best accomplish its purpose, nitrogen should be applied either in the late fall or well in advance of tree growth in the spring, and generally before the soil is fit for cultivation. Such applications, however, are soon available to the trees and without appreciable loss of the fertilizer applied.

The various forms of nitrogen—nitrate of soda, ammonium nitrate, ammonium sulphate, and cyanamid—are about equally effective if applied at the proper time. Ammonium sulphate and cyanamid can be used to advantage in the late fall, but nitrate of soda and ammonium nitrate should be used as early spring applications, and as required during the growing season. Recent experience indicates that cyanamid should not be applied to sweet and sour cherries at any time. For peaches and plums it is best applied in the late fall.

In eastern Ontario, for apple and sour cherry orchards, spring application of all forms of nitrogen is generally preferred, as fall applications, unless carefully timed, may predispose the trees to winter injury. This applies to both sod and cultivated orchards.

Moderate Nitrogen Applications—A basic recommendation for **cultivated** orchards is—nitrate of soda ¼ lb., or ammonium sulphate 1/5 lb., or cyanamid 1/5 lb., or ammonium nitrate ⅛ lb. per year of tree age. Thus a 20-year old tree would need 5 lb. nitrate of soda, or 4 lb. ammonium sulphate or cyanamid, or 2½ lb. ammonium nitrate.

For **unmulched** sods, as noted on page 43 (which see) the above amounts, in general, need to be doubled. For **sod mulch** the nitrogen requirement will depend on the type of sod and of mulch (see pages 37, 42).

Nitrogen Equivalent Table—The term "nitrate of soda or equivalent" is used frequently in recommendations for fruit crops. The table below indicates the approximate amounts of ammonium sulphate, cyanamid, and ammonium nitrate required in place of stated amounts of nitrate of soda.

Nitrate of Soda 16%	Ammonium Sulphate 20%	Cyanamid 20%	Ammonium Nitrate 33.5%
100 lb.	80 lb.	80 lb.	48 lb.
200 lb.	160 lb.	160 lb.	96 lb.
250 lb.	200 lb.	200 lb.	120 lb.
300 lb.	240 lb.	240 lb.	144 lb.
400 lb.	320 lb.	320 lb.	192 lb.

Broadcast—Surface application of mineral fertilizers to cultivated orchards should be made when the soil can be worked immediately, or just prior to the planting of the green-manure crop, otherwise much of the phosphate and potash is likely to be quickly fixed in the top inch or so of the soil and rendered unavailable. The green-manure crop will take up part of the minerals applied. Later, decomposition will release the minerals at a suitable depth and in a form which seems to be important for the trees.

Deep Placement—Methods of fertilizing orchards have undergone considerable change in the last few years. Broadcasting of fertilizers previous to plowing and disking, and to orchards in sod, has been the accepted custom for many years. While this method is useful for shallow-rooted fruit crops such as berries yet it has its limitations for tree fruits. One limitation is the inability of the mineral fertilizers to percolate through the soil to sufficient depth to reach the main root area; also most Ontario soils have a high fixation factor which ties up in a non-available form too much of the minerals applied broadcast.

A recent development for overcoming these difficulties is the deep placement of mineral fertilizers by machines designed to sow the fertilizer in a continuous ribbon at any desired depth between two and eighteen inches. These machines are a combination of a sub-soiling plow plus a modification of the seed drill. The fertilizer tube is placed behind the chisel tooth of the sub-soiler and the fertilizer flows from a hopper placed above.

The deep placement of mineral fertilizers in this manner assures their reaching the depth of greatest root concentration, and in a narrow band or ribbon which reduces soil fixation to a minimum by reducing the free dispersal of fertilizer throughout a large volume of soil. Another favourable result is the breaking up of plow-sole and heavy subsoil layers by the subsoiling action of the plow. This opens up the subsoil for better drainage and aeration and allows the roots to penetrate farther into subsoil often rich in minerals.

Cases of mineral deficiencies have shown immediate benefit from the deep placement of minerals in zones occupied by feeding roots; and in some cases where drainage was a problem, the opening up of the subsoil has greatly relieved the condition. These machines have been used in apple, pear, peach, plum, and cherry orchards, vineyards and berry plantations. Experimental data are lacking on the results of deep placement in tree fruits but there is much evidence of its beneficial effect on truck crops, where the fertilizer is placed below and to the side of the seed rows. On the basis of orchard observation alone, it appears a worth-while method of applying mineral fertilizers.

In applying fertilizers by deep placement care should be taken to keep well away from the tree to avoid unnecessary cutting of roots. As a rough guide the machine should be run just outside of the outer branches, or in cases of large trees meeting at the centre, once down the centre of each tree space. Application made both ways of the orchard will ensure the tree being surrounded by a "square" of fertilizer. It is most important that deep placement be carried out in the fall **only**, well after growth has ceased, to avoid a possible check to the tree by cutting of active feeding roots. In late fall when the tree is dormant the loss of a few roots will

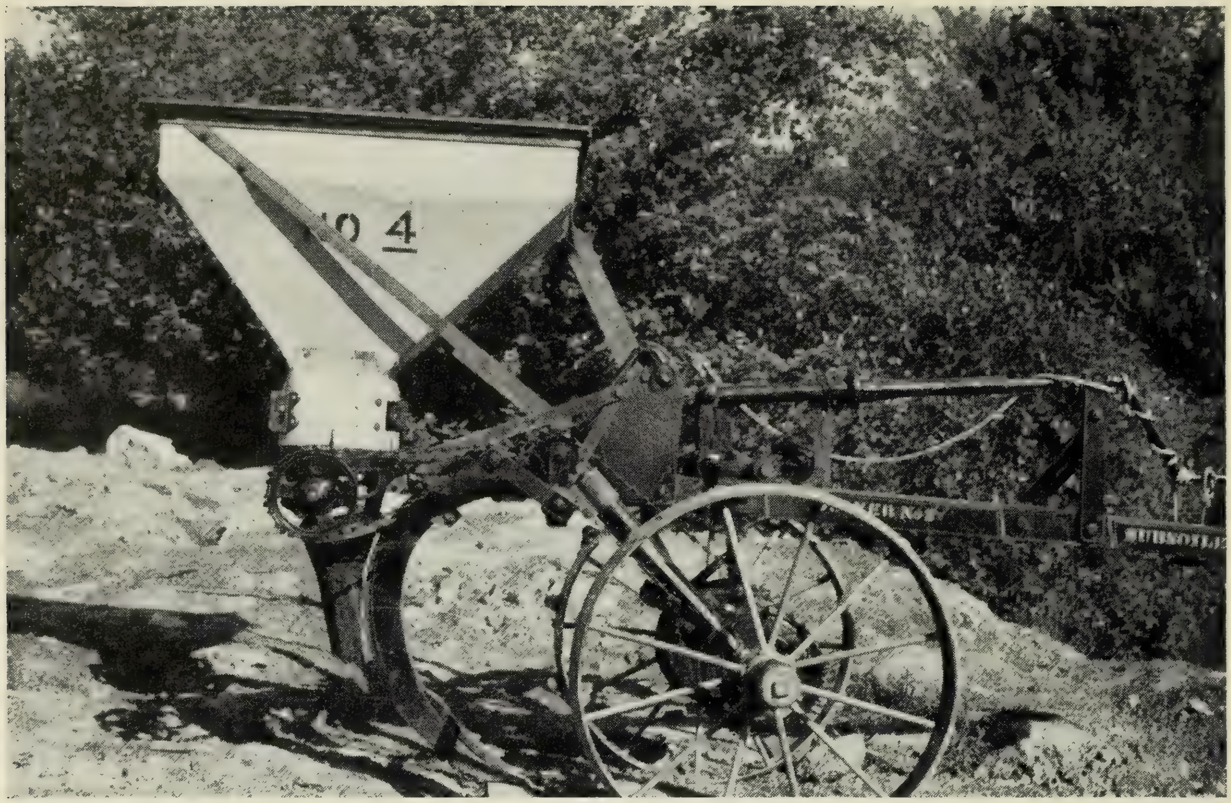

FIG. 16. The subsoiler is a valuable implement for breaking up a plow-sole or compacted soil. It may be fitted as shown with a hopper attachment for deep placement of fertilizers.

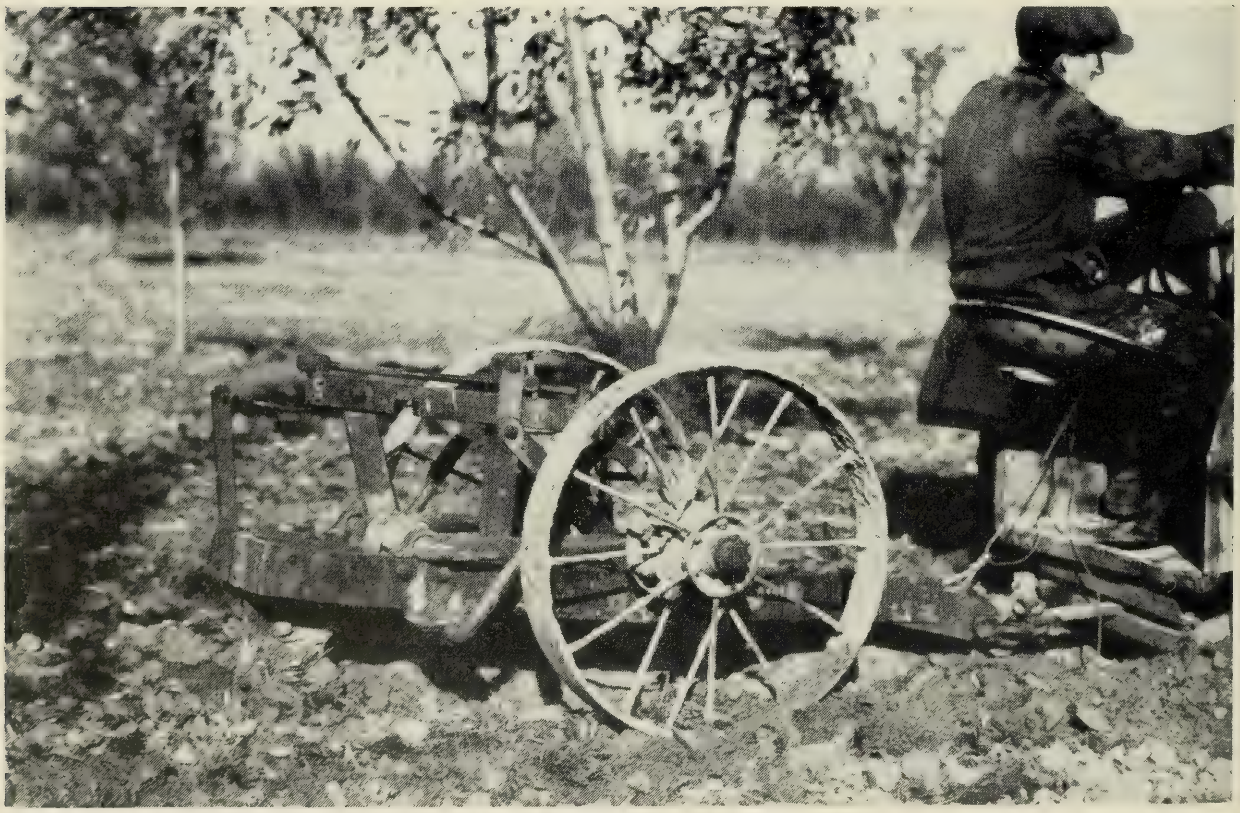

FIG. 17. A subsoiler (without deep-placement fertilizer attachment) in operation. The work should be done in late fall, and under dry soil conditions, to minimize the effects of root injury to trees, and to secure the maximum shatter-effect on the subsoil.

not seriously affect growth the following spring, but if carried out in the spring this root cutting may seriously upset the feeding ability of the tree at a time when the demand for nutrients is great.

Moderate Mineral Applications—In tree fruits it is common practice to make separate applications of single-element fertilizers. The nitrogen is usually applied as an early spring application while the minerals are applied in the late fall. Where a soil test shows mineral deficiency, phosphate and potash may be applied singly depending on which deficiency is present, the amount being dependent on the degree of deficiency. In general, where nitrogen is applied separately, an 0-12-20 mineral fertilizer at 300 pounds per acre is satisfactory. However, for growers who desire to combine nitrogen and minerals, a complete fertilizer, 4-8-10 is valuable as a "maintaining" fertilizer in orchards, whether cultivated or not, which are growing and fruiting normally and which are already known to be reasonably well supplied with minerals. It is of particular value in stimulating growth of green-manure crops although, for apple orchards, because of the nitrogen content, the application of 4-8-10 should be made in late fall or early spring, not delayed until June or July when the green-manure crop is planted. Apply 600 pounds per acre. It must be emphasized that additional nitrogen may be required, depending on the type of soil management followed.

Where no deep-placement machine is available, sowing the fertilizer in the bottom of a plow furrow and replacing the furrow slice will accomplish much the same results. In this case it will not be possible to apply the fertilizer as deeply as with a proper machine.

LEAF DIAGNOSIS OF NUTRITIONAL NEEDS

It is possible to diagnose some nutritional ailments of fruit crops by foliage symptoms. Where only a single nutritional disorder is responsible it is comparatively easy to make such a diagnosis but where two or more elements are lacking at the same time the symptoms are hard to diagnose and are often confusing, the element of greatest deficiency sometimes masking the appearance of the others. It becomes a matter of experience and observation to enable one to diagnose deficiencies under orchard conditions. The following very brief descriptions cover the more commonly encountered deficiencies. For a more detailed discourse on deficiency symptoms see Publication 802, Orchard Soil Management and Plant Nutrition in Eastern Canada, Dominion Department of Agriculture, Ottawa.

Nitrogen Deficiency—Most growers already know the appearance of this deficiency symptom since they know that a light foliage colour is usually tied up with low nitrogen supply. The first indication of a nitrogen deficiency is the pale green colour of the leaves instead of the dark green colour characteristic of healthy trees. The leaves will usually be smaller than normal, the twigs will be spindly and short. Another symptom in advanced stages is the reddish colour of the bark on the main framework of the tree. Apple leaves turn from the pale green colour to yellow and will fall off in the yellow stage. Peach leaves turn from pale green to yellow and develop reddish spots, the centres of which may fall out. Leaves on the ground have these red spots.

Phosphorus Deficiency—Phosphorus deficiency alone is seldom encountered in the orchard, usually being accompanied by some additional deficiency. On peaches, phosphorus deficiency symptoms develop as a yellow blotched or mottled appearance between the veins of the leaves, with the older leaves falling off readily. On other fruits the leaves will be somewhat smaller than normal and at first will have a dull dark-green colour followed by a paler green overlaid with a reddish bronze appearance.

Potassium Deficiency—For the most part all fruits react in much the same way and marked symptoms develop where there is a deficiency. The leaves first show reddish dots or large blotches **along the margins**; in later stages these reddish areas will join together to form a brown margin around the leaf which finally turns a grey or "cigar-ash" colour. At this stage the leaves will tear or tatter as the wind breaks out the the crisp dead areas. On peach foliage this grey colour seldom develops. At the brown stage the peach leaf will form a layer of abscission cells around the affected parts, which part then drops out, giving the margin of the leaf a scalloped appearance. With potassium deficiency the entire leaf seldom drops off.

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THE STRAWBERRY IN ONTARIO

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THE STRAWBERRY IN ONTARIO

Although this is primarily a cultural bulletin, the commercial value of the strawberry crop in Canada and in Ontario is of sufficient importance to warrant the inclusion of a few figures on production and prices.

SOME PRODUCTION FIGURES

Quantities and Values in Canada — Strawberry production and prices in Canada have fluctuated considerably during the last twenty-five years. In 1920 Canada produced approximately 15,000,000 quarts, of which Ontario's share was about 10,800,000 quarts. Since the average price per quart was 17 cents the total value for all Canada was $2,550,000.

The highest production year for Canada, 1939, gave 29,394,000 quarts but the price was only a little in excess of seven cents per quart, so that the value was only about $2,116,000. In 1947 the estimated commercial crop for Canada (exclusive of the three Prairie Provinces) was about 25,000,000 quarts. Taking 24 cents as the average price for this crop the value was about $6,000,000.

Commercial strawberry production in Canada is carried on chiefly in British Columbia, Ontario, and Quebec, with considerably smaller quantities produced in the Maritimes and the Prairie Provinces.

Table 1 shows the average annual crop for the period 1941-45, in the main producing areas, and the estimated crop for 1947.

TABLE 1. STRAWBERRY PRODUCTION IN CANADA*

	Average Annual Crop for Period 1941-1945 Quarts	Crop for 1947 (Estimated) Quarts
British Columbia	5,447,400	6,767,000
New Brunswick	1,075,400	1,200,000
Nova Scotia	967,000	550,000
Ontario	5,672,300	10,461,175
Quebec	3,996,000	6,000,000
Totals	17,158,100	24,978,175

* No figures are available for Prince Edward Island and the three Prairie Provinces.

Quantities and Values in Ontario — For the purpose of crop statistics, Ontario is divided into two main producing areas, east of Toronto, and west of Toronto. Strawberry production on this basis is given in Table 2.

TABLE 2. STRAWBERRY PRODUCTION IN ONTARIO

	Average Annual Crop for Period 1941-1945 Quarts	Production in 1946 Quarts	Production in 1947 (Estimated) Quarts
East of Toronto	1,422,300	3,099,000	4,338,600
West of Toronto	4,250,000	4,660,470	6,122,575
Total, Ontario	5,672,300	7,759,470	10,461,175

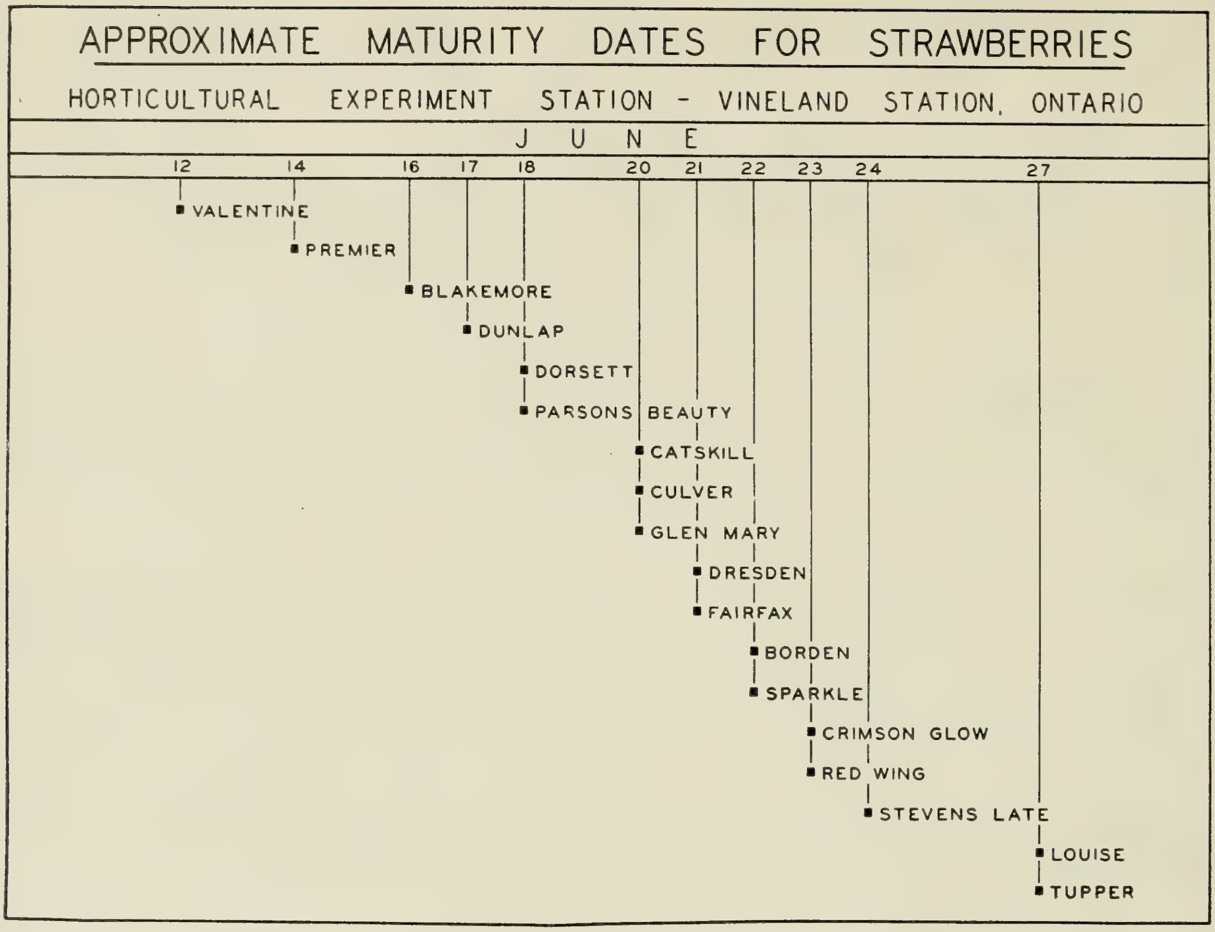

Fig. 1. At Vineland the *average* date for first picking of Valentine is June 12, for Premier June 14, etc., down to Louise and Tupper, late varieties ripening their first fruits June 27, or 2 weeks after Valentine. Elgin, not shown on the chart, is about 3 days after Louise.

In the area west of Toronto approximately 2,163 acres were grown in 1946, the main producing sections being Norfolk County (600 acres), Niagara district (500 acres), Peel-York Counties (300 acres), Burlington district (225 acres), and Elgin-Oxford Counties (145 acres). The balance (393 acres) was distributed over the rest of this western section, mainly in Georgian Bay, Sudbury-Soo, and Head of the Lakes.

Although the strawberry acreage figures are not given for the individual producing sections east of Toronto, yet this part of the Province accounts for quite a considerable portion of the total Ontario crop — nearly 40 per cent in 1946 and over 40 per cent, estimated, in 1947 (Table 2).

In the years 1920, 1933, 1935, 1940, and 1945 the strawberry crop in Ontario was between 10,000,000 and 12,000,000 quarts, but the total annual value varied greatly from year to year due to differences in prices.

TABLE 3. PRODUCTION AND VALUE OF THE STRAWBERRY CROP IN ONTARIO, FOR THE YEARS 1920, 1933, 1935, 1940 AND 1945

Year	Quarts	Price per Quart	Value (Approximate)
1920	10,800,000	17 cents	$1,836,000
1933	10,893,000	9 "	980,000
1935	11,819,000	7 "	827,000
1940	10,966,000	6 "	658,000
1945	10,461,000	24 "	2,510,640

VARIETIES — DESCRIPTIVE NOTES

All varieties in these descriptive notes are perfect-flowered, with the exception of Louise and Tupper which are imperfect. See Figure 1 on page 2 for ripening dates.

Aberdeen — This variety is receiving some publicity in New Jersey and other eastern states, chiefly on account of its resistance to red-stele root rot. It is a good plant-maker and a moderate cropper. Ripens in mid-season. The fruit is of medium size, rather unattractive, only fair in quality, quite acid.

Blakemore — A profuse plant maker necessitating thinning. Susceptable to the June Yellows disease but disease-free stock is available from United States sources. Appears to be resistant to root rot. Fruit firm, light red, acid. A moderate to good cropper. Ripens soon after Premier. It has become one of the leading varieties in the South-Eastern States.

Borden — Recently introduced by the Central Experimental Farm, Ottawa, where it originated. A fair to good grower, making a moderate number of runners. The fruit is of medium size, moderately firm and of a medium red colour. Quality is fair and the crop fair to good. Ripens in late mid-season, about one week later than Premier.

Catskill — Forms sufficient plants, and is a good cropper. Fruit is usually large and attractive but sometimes poorly shaped. It is moderately firm and of good quality. Ripens in mid-season, nearly a week later than Premier. Worthy of trial as a dessert berry. Some stocks of this variety are deteriorating in vigour, suggesting the presence of disease.

Crimson Glow — A new variety from the New Jersey Experiment Station. Vigorous, healthy, and makes plenty of runners. Fruit medium to large and of medium colour, quite firm. Quality and crop are both good. Ripens nine to ten days later than Premier. Well worthy of a trial.

Culver — A good grower, normally making plenty of plants and bearing well. Fruit is medium to large, solid red, fair to good quality though rather acid. Ripens in mid-season, slightly later than Parsons. Rated highly for preserving by the Geneva, N.Y. Experiment Station.

Dorsett — A vigorous grower, making plenty of plants, and bearing moderately well. The first few pickings give medium to large fruit but in later pickings the size falls off considerably, especially on the poorer, drier soils. The fruit is firm, bright red, very attractive and of excellent quality. Ripens several days later than Premier. Useful as a high-class dessert berry for a select trade.

Dresden — A very vigorous grower and produces plenty of plants — almost too many. On good soil with sufficient moisture it produces a good crop of medium to very large fruit and maintains size very well throughout the season. It is quite a light red in colour, possibly too light, although fairly attractive. Inclined to be a bit soft, fair in quality but rather acid. It ripens in mid-season, about a week later than Premier.

Dunlap — Lacks somewhat in vigour and may make many, rather small, plants. Compared with some of the newer and better varieties it may not have much to commend it, its fruit being rather small, soft and of only fair quality. However, it has a place where the better kinds do not flourish as it is more adaptable to widely varying soil and climatic conditions than most varieties and so is included in the recommended list.

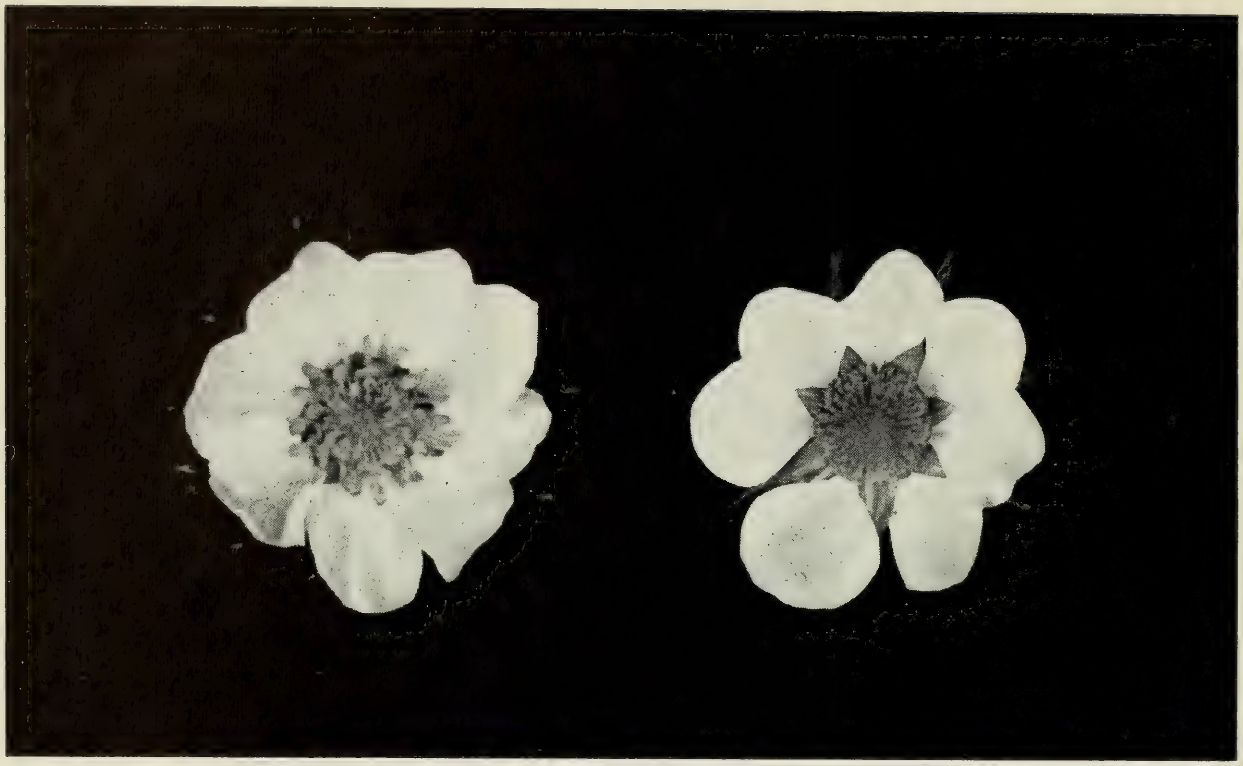

Fig. 2. Perfect (left) and imperfect strawberry blooms. Perfect-flowered varieties are self-fruitful and may be planted in solid blocks of one variety. Imperfect-flowered varieties have no pollen of their own, and so require to be interplanted with a perfect variety to insure pollination.

Elgin — Originated a few years ago, at the Central Experimental Farm, Ottawa. A fairly vigorous grower and good plant-maker. Fruits are large, not any too firm, of medium-light red colour, and fairly attractive. Quality fair, and gives moderate crops. Ripens late, even later than Louise. Being perfect-flowered and a late bloomer, it could be planted with Louise as a pollinator.

Fairfax — A very vigorous grower, a good plant-maker, and a moderate cropper. The first few pickings give some fine large fruits but the size falls off very considerably in later pickings, even more so perhaps than with Dorsett. Requires good soil, well supplied with moisture. The fruit is very firm and of exceptionally good quality. Also it is quite attractive, except when a bit overripe, when it becomes rather dark in colour. Ripens about a week later than Premier. An excellent dessert berry.

Louise — A new seedling from the C.E.F. Ottawa. Rated as a good late variety. A vigorous grower and makes plenty of plants. Blossoms **imperfect**, hence needs a perfect-flowered variety grown with it as a pollinator. Such varieties as Crimson Glow, Redwing, Sparkle, and Elgin blossom late enough to be suitable as pollinators.

Parsons — Vigorous, good plant maker and a good cropper on the better strawberry soils. The fruit is of medium size, fairly attractive, firm with fair quality, but rather acid. Used for preserving.

Pathfinder — This is a new variety from the New Jersey Experiment Station. It is receiving some publicity in that State and adjoining districts. It may have value as an early sort in parts of Ontario.

Premier — A good plant-maker under good cultural conditions although somewhat susceptible to root rot. It is a heavy cropper, with bright, attractive and moderately firm fruit of nice quality. Ripens early. Premier is more extensively grown commercially in Ontario than any other variety, particularly in the main strawberry districts.

Red Wing — Another New Jersey variety. A good plant maker vigorous and healthy. Fruit medium to large and of medium dark colour, attractive. Moderately firm and of good quality. Yields well and ripens nine or ten days later than Premier. Well worthy of a trial.

Sparkle — This probably is the best recent introduction from the New Jersey Experiment Station. A vigorous grower, producing plenty of plants. Healthy, and reputed to be resistant to red-stele disease. Fruit medium to large and of medium red colour, attractive. It is moderately firm, and of good quality, a good cropper and ripens late — over a week later than Premier. In New York State it is rated highly for "quick-freeze" preserving. Well worthy of an extensive trial.

Tupper — Another new Ottawa seedling. A good plant-maker and healthy. **Imperfect** flowered. Fruit large, but soft and of poor quality. Ripens with Louise but not as good as that variety.

Valentine — A recent Horticultural Experiment Station introduction which produces very sturdy plants and enough of them to make a good row. It is deep-rooted which helps it to withstand drought conditions. It is a good cropper, and the fruit is fair to good in quality. The colour is dark solid red, perhaps a bit too dark for some markets, especially if over-ripe. Its size is medium to large which it holds over a long season. Recommended for trial or limited commercial planting on account of its earliness and firmness of fruit. It is usually a full picking earlier than Premier. One grower in B.C. who has had Valentine for four years, says . . . "it is the best early berry I have grown". For home canning it is quite desirable, as it retains its shape and colour better than most varieties. Valentine and Sparkle would be a very good combination for the home garden, giving a long fruiting-season from the first Valentine to the last Sparkle.

Vanrouge — First distributed several years ago by the Horticultural Experiment Station. It produces sturdy plants and sufficient for a good row, but yield is only fair. Ripens in early mid-season. The fruit is large, bright red, attractive, firm and of very good quality. For the "quick-freeze" method of preserving it has been outstanding in tests at the Dept. of Horticulture, O. A. College, as it retains its flavour and colour better than any other variety so far tested. It is, however, not being recommended for commercial planting on account of its indifferent yield; also because the upper part of the fruit turns too dark when fully ripe.

Fig. 3. Trial plots at Vineland. Many new varieties of strawberries are being introduced. Those which may have value for Ontario conditions are given a thorough trial by Experiment Stations.

RECOMMENDED VARIETIES

(In order of ripening, from early to late)

General —

(a) Commercial planting — Valentine, Premier, Dunlap, Dorsett, Parsons, Fairfax, Sparkle.

(b) Limited (trial) planting — Catskill, Culver, Dresden, Crimson Glow, Red Wing, Louise.

East of Kingston —

(a) Commercial planting — Premier, Catskill, Dresden, Louise.

(b) Limited (trial) planting — Valentine, Pathfinder, Borden, Tupper.

SOME OF THE NEWER VARIETIES

New varieties of strawberries are continually appearing. Most of those of recent origin are from crosses made at Experiment Stations throughout Canada and the United States.

The following brief notes on some of these newer varieties, excepting the Fairland and Franklin, are adapted from information obtained from the Agricultural Experiment Station, Geneva, N.Y.

Fairland (U.S. 3205)* — From a cross between Aberdeen and Fairfax. The plant is resistant to red-stele root disease, hence may be planted where this disease is a factor. The fruit is large, light bright red, somewhat firmer than Premier and as productive as that variety. Tests in several states indicate that it is adapted to the region where Premier is grown. Several days later than Premier, ripening about Fairfax season.

Fairpeake — Introduced for trial in the Maryland area. The plant has medium vigour. The fruit has good quality, is firm with a tough skin. Ripens late.

Franklin — Originated with Mr. C. B. Crawford, Cooksville, Ontario. An excellent plant-maker. Fruit is bright red and attractive. Unless quite ripe, it is likely to have a hard core. Skin rather tender. Quality moderately good, rather acid. A very good cropper, ripens in early mid-season.

Maytime — An early high-quality variety for Maryland, not very productive farther north.

Midland — Suggested for Maryland, not very productive in New York State. Very firm, of good quality and lighter in colour than Fairfax. Ripens with Premier.

Red Star* — In New York State this variety is not a good enough plant-maker, neither is it very productive. Fruit firm, of good quality, attractive, late.

Star Bright — Similar to Red Star as grown in New York but not as late. Both this and Red Star are probably more suitable for trial in Maryland than further north.

Suwannee* — The newest U.S.D.A. variety, from a cross between Missionary and Premier. Introduced particularly for the South. Plants are vigorous and usually make a good row. The fruit is of medium size, firm, attractive, and of good quality.

Temple* — A Maryland introduction, from a cross between Aberdeen and Fairfax. Resistant to red-steele and recommended for localities where that disease is prevalent.

POLLINATION

Strawberry varieties fall naturally into two main groups, those in which the flower parts are complete (perfect) and those that are incomplete (imperfect). In the latter group the anthers, or pollen-producing male organs, are lacking. (See Figure 2 on page 4.)

All varieties listed in this bulletin, except two, are perfect-flowered; these two exceptions are Louise and Tupper. Other imperfect sorts are the old Bubach and Sample; also, of more recent origin, the Portia.

While most varieties of strawberries fall definitely into the two categories, perfect and imperfect, there are a few on the border-line. A case in point is the Glen Mary, in which the first-formed anthers are only rudimentary and in consequence produce practically no pollen. The lack of pollen in the first blossoms undoubtedly gives rise to the rough, first-formed fruits, characteristic of this variety.

An imperfect variety, or even one on the border-line, is at a great disadvantage from a practical standpoint, as it necessitates interplanting with perfect-flowered sorts to ensure pollination. The usual practice is to plant one row of the perfect-flowered variety, to three or four of the imperfect. In actual practice the imperfect-flowered kinds are seldom grown now, except perhaps for some special reason such as Louise for lateness.

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* First fruited in Horticultural Experiment Station tests in 1948.

Whether pollen is actually carried to the imperfect variety will depend very much on the activity at blossoming time of bees and other pollen distributors, and this will, in turn, depend very much on weather conditions. In cold, wet, blustery weather these insects are not very active in visiting blossoms, and so very little pollen is distributed from flower to flower. Even in perfect-flowered varieties, pollination may be very spotty when the weather is unfavourable to insect activity, resulting in some of the fruits being irregular.

LOCATION AND SITE

Location — Strawberries for home use may be grown in almost any location but, for a successful commercial enterprise, location may play an important part and should be selected with due consideration given to marketing facilities, labour supply, climatic conditions, and soil. It is obvious that it would be very unwise to produce strawberries on a commercial scale if there were no means of marketing them, or if the extra help needed for picking was not available. Also, climatic conditions and soil must be favourable or the venture will probably be a failure.

Site — The actual site for a strawberry plantation must be chosen with care. Apart from the character of the soil, which will be discussed later, drainage is the most important thing to consider in choosing the site. Good surface drainage and under-drainage are essential. In fact, the former is often more important than the latter. Standing water is always harmful to strawberry plants, and so must be prevented from accumulating by efficient surface drainage. This means that the ground should be somewhat sloping and should be free from depressions or hollows. Under-drainage may not be of much use in removing surplus water when the ground is still frozen after the early spring melting of snow, but it helps to prevent the ground from remaining too wet after a prolonged rainy period.

For early fruit, a light soil and warm southern slope, if free from frosts at blossoming time, are to be preferred. For late crops, a northern exposure on heavier soil is preferable; this is likely to give heavier yields due to a more adequate supply of moisture.

Some protection from strong drying winds may be of considerable value in some localities, particularly in spring and early summer; also it will avoid the annoyance of the mulch being blown out of place.

Frost Injury — In some seasons there may be considerable frost injury to the open blossoms or even to those that are not actually open, but in the late-bud stage. When the blossoms are fully open, the pistils (female parts) may be frozen and killed outright in which case the fruit does not develop. If the injury is only partial some of the pistils may be damaged and the rest may be uninjured resulting in unevenly-formed fruits.

Frost injury may be avoided to some extent at least, by planting strawberries on sites that have good air drainage, particularly avoiding frost pockets. As in the case of insufficient pollination, it is evident that frost injury also is a cause of mal-formed fruits, most "nubbins" and "catfaces" being due to these two factors.

SOILS

Strawberries can be grown on a wide range of soils, from light, sandy loams, to the clay loams. In actual practice the lighter soils usually are preferred as they are easier to work, are earlier, and provide a better bed for rooting. Also, chickweed is not likely to be so troublesome on these as on the heavier soils. The lighter soils, though, will probably be low in organic matter.

SOIL PREPARATION AND FERTILIZATION

Preparation of the soil for strawberries is of the utmost importance and should begin at least a year in advance of planting. Consult Ontario Bulletin 457, Orchard Soil Management, for detailed information on soil management in relation to horticultural practice.

Owing to the comparatively shallow rooting of the strawberry, the short time from spring to harvest, and the heavy weight of fruit in proportion to plant, the soil must have a high moisture-holding capacity and must also be well supplied with readily available food material. This implies a plentiful supply of organic matter in the soil.

Organic Matter — Farm manure is undoubtedly the best form in which to add organic matter to the soil. It is, however, impossible in many cases to get sufficient to keep up the the organic-matter requirements for the strawberry, and so hay, straw, and green-manure crops will have to be used as supplements. Manure and the supplements together will give better results than the latter alone, as the presence of the manure aids in the decomposing process. Also, if much straw and hay are used, applications of extra nitrogen will be necessary to promote decomposition. With legume hay, no extra nitrogen will be required as legume plants contain sufficient nitrogen for their own decomposition by bacteria.

Various crops may be used for green manuring, including buckwheat, rye, oats, corn, sweet clover, red clover, and soy beans; the latter three are legumes, hence nitrogen-gatherers.

The use of soy beans for green manuring previous to planting strawberries is comparatively new. Recent experimental work shows that when large amounts of soybean plant-material are worked into the soil, root-rot disease is less likely to be a serious factor.

As farm manure and its supplements need to be well rotted before the strawberry plants are to be set out, it follows that they should be incorporated into the soil during the year previous to planting. If the soil requires much building up it will be necessary to grow green-manure crops for more than a year before planting, unless large quantities of farm manure are available.

A heavy grass sod will supply much organic matter, but precautions to avoid injury from white grub must be taken. See under "White Grubs" in the section on Insect Pests on page 24.

Fertilizers — Nothing, so far, has been said about the use of commercial fertilizers, because it was deemed advisable to emphasize first the great importance of having sufficient organic matter in the soil, without which commercial fertilizers lose much of their effectiveness.

It is very difficult to state definitely what fertilizers should be used, and in what quantities, without knowing something as to the supply of food materials, more particularly nitrogen, phosphorus and potassium, that are already in the soil in an available form. Soils vary greatly in this regard, so that the safest plan is to have them analysed, at least for readily available potassium and phosphorus.

As available nitrogen varies considerably during the season, and as it is rather easily lost in drainage water, analysis for this element may not be a reliable guide in deciding whether to apply extra nitrogen. To be on the safe side however, it is usually advisable to add some, unless the soil is unusually rich or unless large quantities of manure are used.

The general fertilizer recommendations for the strawberry, issued by the Ontario Advisory Fertilizer Board, (1946) are briefly summarized.

Organic Matter — Year previous to planting. **Either** twenty tons of manure per acre in the spring **or** six tons of hay or straw in the spring plus 300 lb. nitrate of soda (or one-half the quantity of ammonium nitrate). If legume material is used the nitrogen supplement is unnecessary.

Fertilizers — (a) Year previous to planting. **Either** 400 lb. superphosphate and 200 lb. potash **or** 600 lb. 0-12-10. In either case apply to the green-manure crop to stimulate its growth. (b) After planting. Side dress with 150 lb. of nitrate of soda or equivalent after the plants are well established. On poor soil additional nitrogen, perhaps as a second application, may be needed. If the plantation is to be fruited a second year, further nitrogen will be needed. Apply after the crop is off, when renovating.

Soil Reaction — Strawberries are generally regarded as preferring soils of an acid reaction. Experimental evidence supports this, at least to the extent of indicating that strawberries are acid-tolerant, and that definitely alkaline soils are injurious. This apparent acid-loving nature of the strawberry would seem to indicate the desirability of using fertilizers tending to an acid, rather than an alkaline soil reaction, but unfortunately, sulphate of ammonia, for example, may not be safely applied on the foliage because of risk of plant burning. Also, if advance soil preparation involves the growing of green-manure crops, legumes particularly, then an approximately neutral reaction is a practical necessity.

Working the Land — Thorough working of the land in the year previous to planting strawberries is very important, no matter what system of adding organic matter is followed. If green-manure crops are grown, then the ground must be well worked between crops, and if hoed crops are used they should be well cultivated and hoed throughout the season, the object being, of course, to destroy as many weeds as possible, and particularly to prevent any going to seed. If a clover sod is turned under it must be done long enough before planting time to ensure that it is pretty well rotted. If a grass sod is plowed under it should be done at least two years before planting to strawberries, on account of the danger from white grub, and in the year previous to planting a hoed crop should be grown.

Manure should be applied and worked in well the year prior to planting. It can, in fact, be put on the land in the spring when hoed crops or green-manure crops are to be grown and more can be added when the green-manure crops are being plowed under. Also, it can be applied late in the fall, plowed in at once and left this way until spring. If, however, erosion is likely to be a serious factor, it is better to give a trash disking in the fall and defer the plowing until spring. At the time of spring working, the chemical fertilizer should be applied. It can be sown broadcast by hand, or, if the acreage is large enough, by fertilizer drill. If it has been impossible

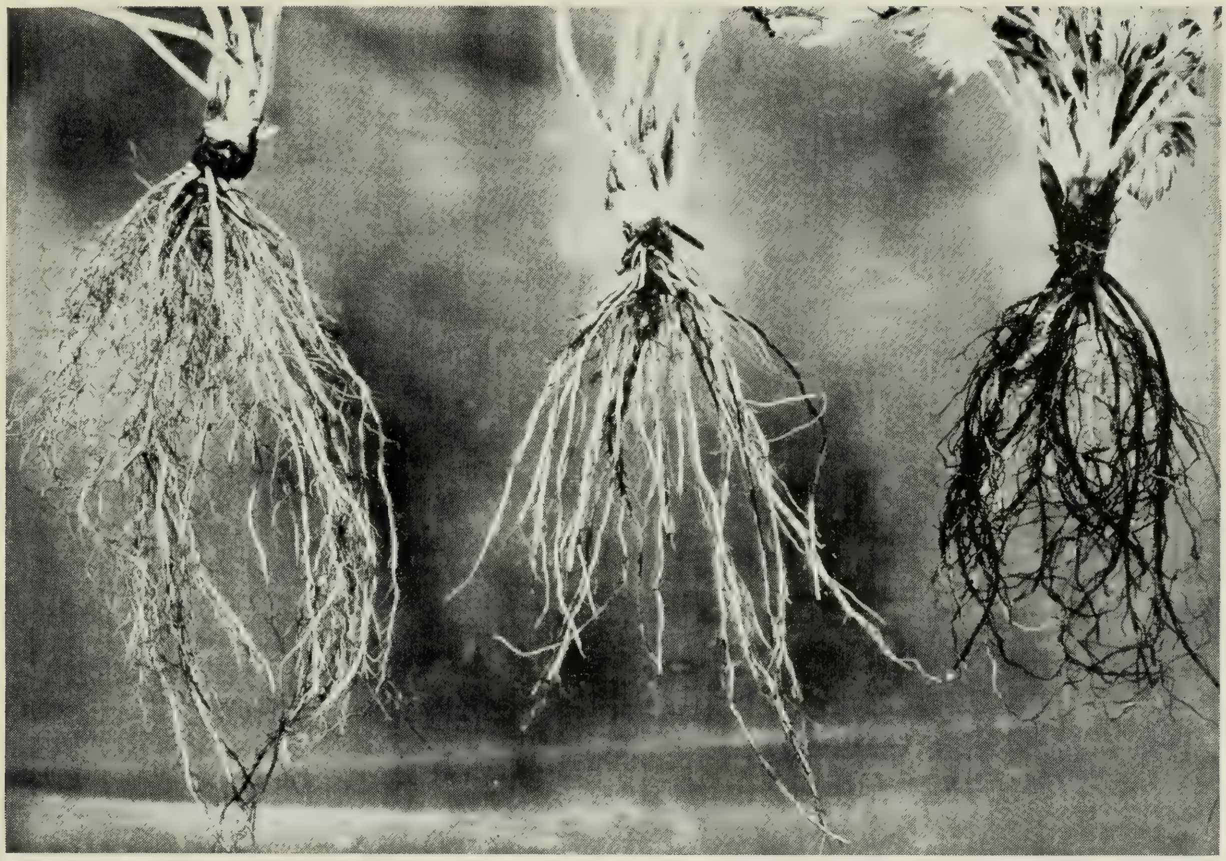

Fig. 4. Select healthy-rooted plants only, for the new patch. Plant at left, roots nearly all healthy, and fibrous; centre plant, some root rot (black root) and lacking fibrous roots; right, severe root rot.

to carry out the full soil improvement program before planting time, an additional application of manure may be given — 10 tons or more per acre, well rotted — and worked in with the fertilizer.

To complete the soil preparation, further disking may be necessary, followed by harrowing and rolling. Judgment must be used concerning the right condition of the soil for carrying on these operations; it should be dry enough so that it is friable and crumbly; if inclined to be wet the rolling should be omitted. The final operation is marking the position of the rows with a wooden marker, pulled by one or two men. It is important to have the rows straight, as cultivation is much easier than when they are crooked.

Rotation of Strawberries — The prevalence of root rot in the older strawberry-growing districts has been brought about to a great extent by overcropping with strawberries; strawberries have followed strawberries too soon and too often on the same piece of land. This has resulted in a building up in the soil of the organisms that cause strawberry root rot; hence it is now recommended that strawberries should not be grown more than once in five years on the same land. Just what crops can be used in a long rotation will have to be determined by the individual grower. On small areas of expensive land it may be difficult to work out satisfactory rotations, but cash crops will, of necessity, be used to a considerable extent. On large areas of comparatively cheap land the strawberry can be fitted in more readily with other farm crops and various green-manure crops. This may account for the tendency for strawberry production to move from the older fruit-growing areas to newer districts, where land is cheaper and less intensively used for strawberry growing.

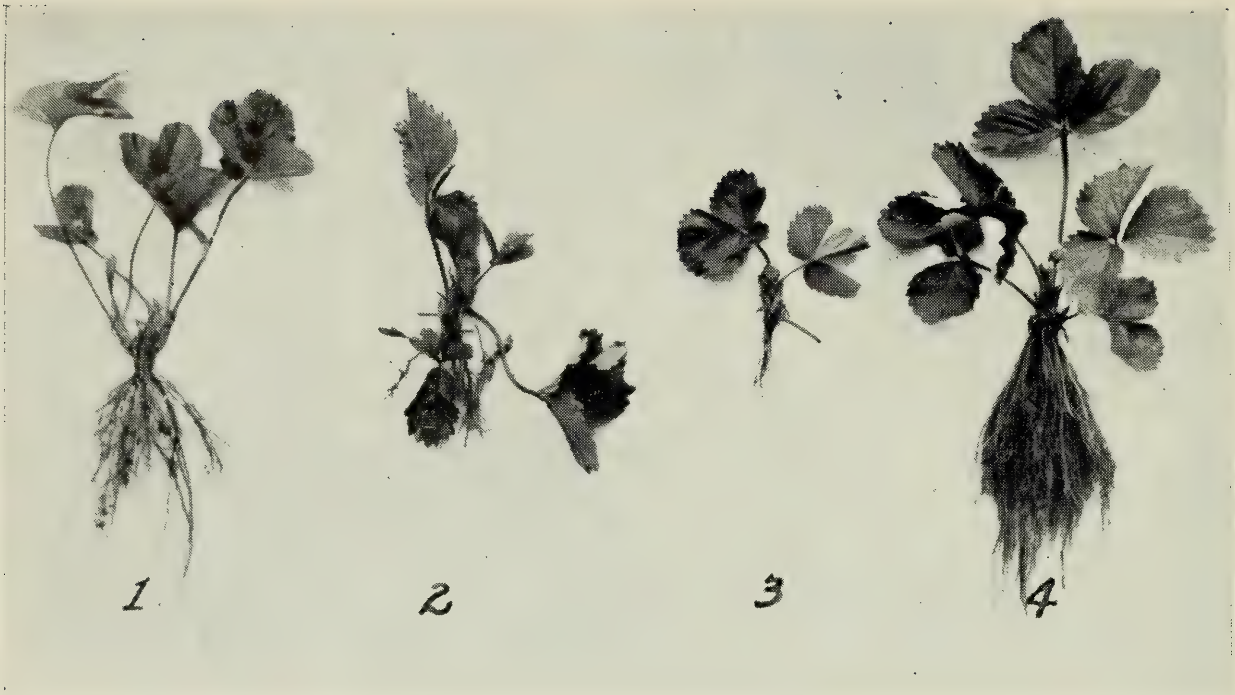

Fig. 5. Select strong, young, healthy crowns; (1) old elongated crown, and sparse root; (2) both crown and root too small; (3) too small, undeveloped plant; (4) well-developed plant.

(Courtesy, Dominion Dept. of Agriculture.)

PLANTING

Systems of Planting — In Ontario, the "matted-row" system is used in practically all commercial plantations. By this method the new runner plants are allowed to grow and root at will, until all the space, from 12 inches to 24 inches in width, is occupied by the young plants. The "hedge-row" systems are merely modifications of the matted row. The "hill" system, which is general in British Columbia, is not adapted to Ontario conditions. It results in the loss of too many plants from heaving, and there is some experimental evidence to show that the eastern varieties do not develop the large plants necessary to this system.

Width of row is partly a question of personal preference, and partly of site and soil; individual growers adapt their method to their conditions. In general it may be said that, providing the individual plants have sufficient room, medium to wide rows will give greater yield of fruit than will narrow rows. On the other hand, if the rows are too wide there will be some crushing of fruit by pickers. Rows of moderate width, originally planted 3½ to 4 feet apart, will give a greater yield per acre than wider rows planted farther apart.

Distance of Planting — This will vary to some extent with the variety and grower's preference; also with locality and soil type. Rows are usually set at 3½ to 4 feet apart with plants from 15 to 24 inches in the row. Poor runner-makers are often set the closer distances. Some growers prefer to space the rows 3 to 3½ feet apart, with plants about 24 inches in the row. This permits of some cross cultivation, provided the rows are straight in both directions. As the plants run freely, cross cultivation is narrowed down and finally discontinued. This method may be used to advantage only where the plantation is nearly square; if it is long and narrow,

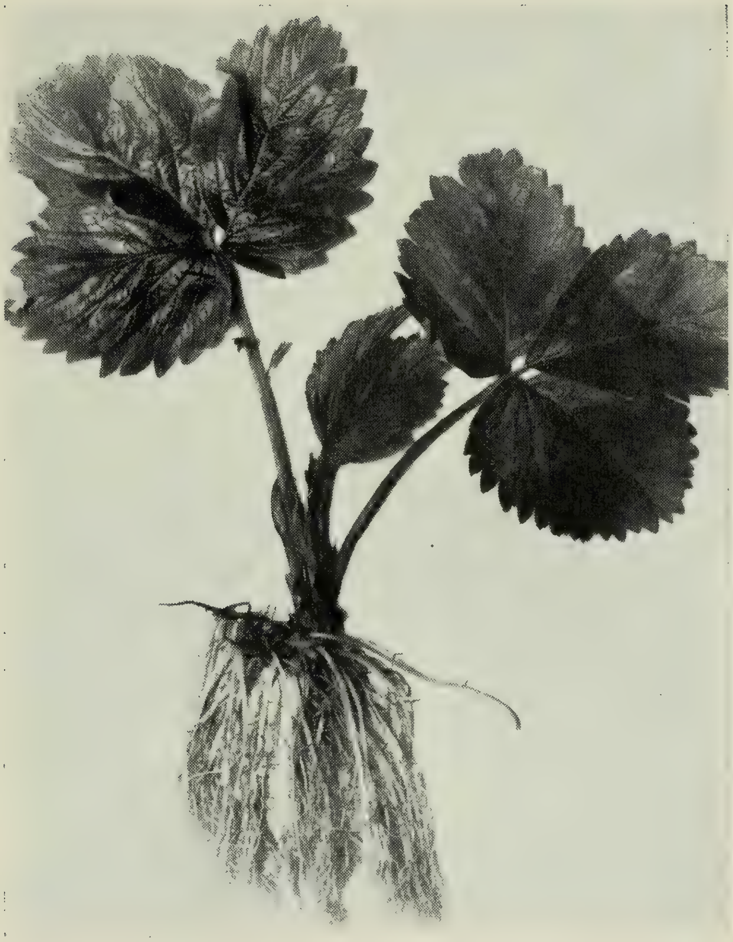

Fig. 6. The type of plant to set; vigorous, well developed, and with a clean, strong, fibrous root-system.

(Courtesy, Dominion Dept. of Agriculture.)

any saving in labour that may result from reducing hand hoeing will be lost by the extra turning necessary for the cross cultivation.

Number of Plants Per Acre — To find the number of plants required to plant an acre; multiply the distance between plants in a row, say 1½ feet, by the distance between rows, say 4 feet; thus, 1½ feet by 4 feet, equals 6 square feet. Divide into 43,560, the number of square feet in an acre. The result, 7,260 is the number of plants required for one acre at this distance of planting.

Selection of Plants — It is becoming increasingly important for growers to set out only the very best plants. The small, weak, late-rooted ones make poor parent plants and should not be used. The best plan is to dig up a row completely, selecting for planting only those with strong crowns and clean, light-yellowish, well-developed, fibrous roots. Old mother plants should never be used for resetting. Of late years, with the great increase in root rot (black root), it has become very important that all black-rooted plants be destroyed — on no account used for planting. It is a common practice now amongst progressive growers to buy plants from growers who are making it their business to produce clean, healthy-rooted plants. Several growers in Norfolk county are making a business of plant production and, on the whole, are sending out good material. Plants from new plantations that have not fruited are best for setting out a new patch.

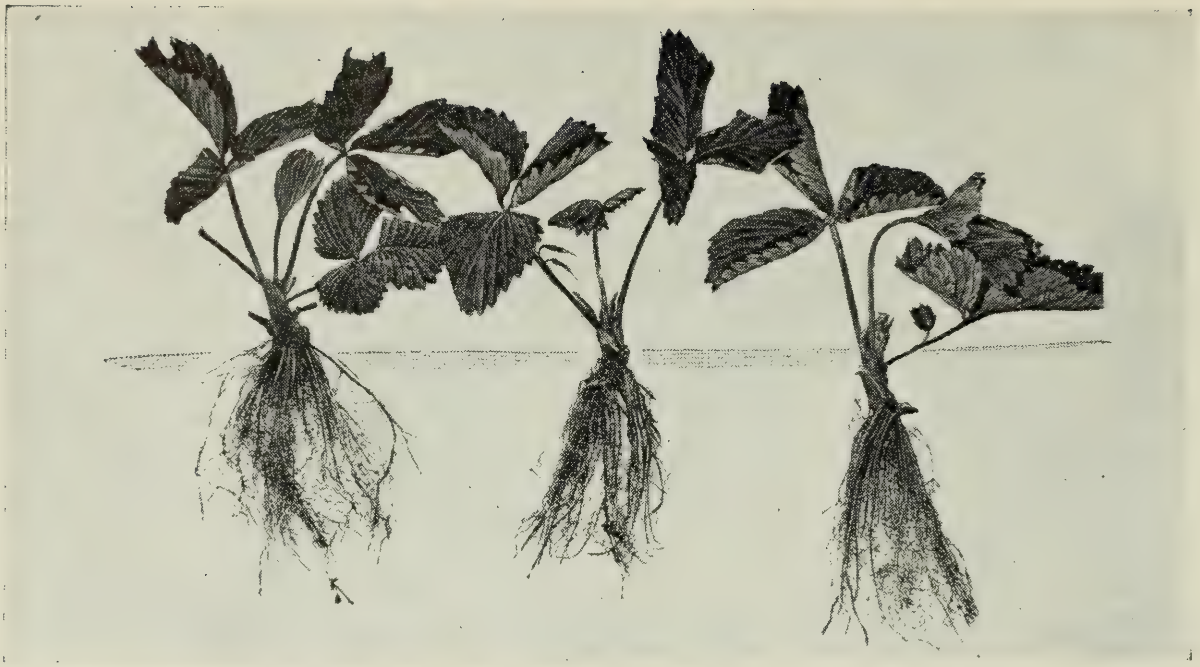

Fig. 7. The plant should be set so that the crown is level with the ground surface. The centre plant above is correct, the left plant is too shallow, and the one on the right, too deep.

(Courtesy, Dominion Dept. of Agriculture.)

There is, of course, no particular virtue in bringing plants in from another district or different soil type. If a man has healthy-rooted plants on his own place, or if a neighbour has plants that he knows are free from root rot, and are otherwise desirable, there is no reason why he should not use them and save himself the trouble and expense of going further afield.

Time of Planting — Most growers agree that plants should be set as early in the spring as the land and plants are ready. This is generally during the latter part of April or the fore part of May. The strawberry thrives best under cool, moist conditions which prevail in early spring, and so planting at this time enables the plants to become established before hot weather starts. This early start encourages early runner formation, which results in stronger plants by fall with increased fruit-bud differentiation which, in turn, results in more fruit being formed.

Late-summer planting (mid-August) can be done successfully, if there is enough moisture in the soil and if well-rooted plants are available. If planting is done much later than this the young plants may not be well enough established to withstand severe freezing and they are more likely to suffer from heaving in the spring, due to alternate freezing and thawing. In any case a mulch of hay or straw will be helpful in preventing injury to the young plants.

Usually August-set plants are not well enough developed to bear fruit the following spring and they are handled pretty much in the same way as spring set plants. If, however, they are extra vigorous, and the fall weather favours runner formation and root development, a partial crop may be expected the first season following planting.

Setting the Plants — Plants are usually dug with a fork when several leaves have developed, or just previous to planting. Old decayed leaves and runners are usually removed to facilitate planting. The plants

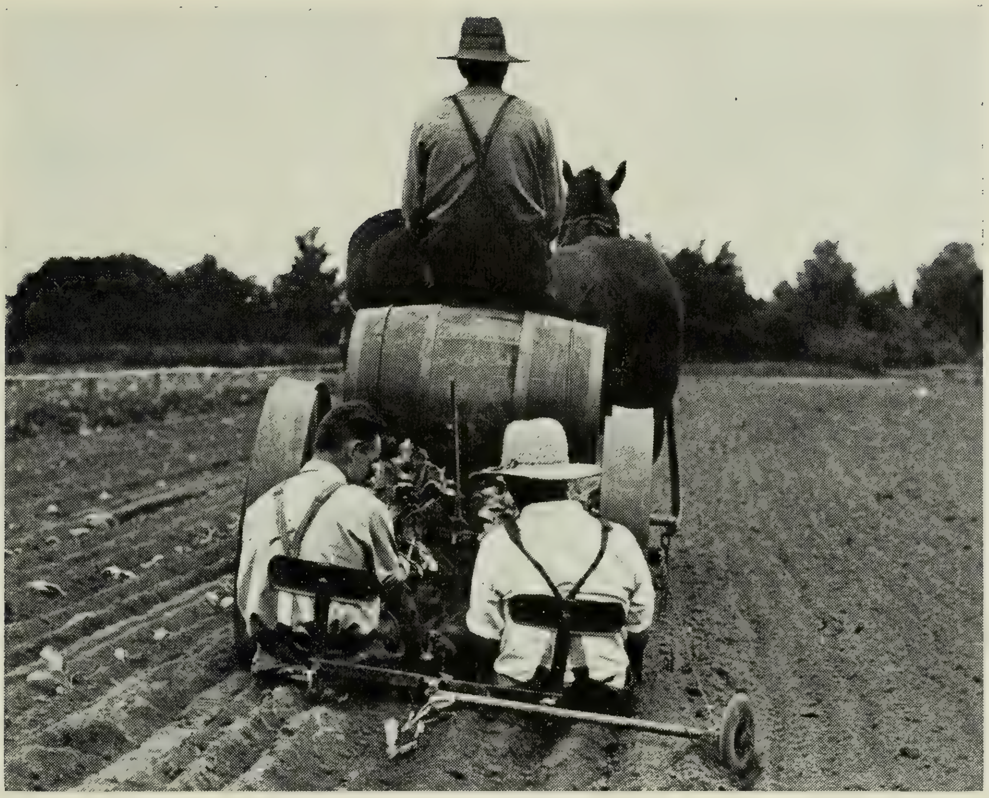

Fig. 8. For large acreage machine planting is almost a necessity. It speeds operations, waters the newly-set plant.

(Courtesy, Macdonald College.)

must be handled so that they will not become dry at any time. A dull, cool, still day is preferable to a bright, windy day. Under the latter conditions plants dry out severely, unless kept covered with moist sacking or other suitable material. If not planted as soon as dug they should be heeled in, that is, planted temporarily in shallow trenches; this protects them from drying.

Planting may be done with a trowel, dibble, spade, long-handled pointed shovel, or machine. The first two implements are used when only a few plants are to be set out in the home garden but are much too slow for any considerable planting. When a spade or a shovel is used, a man and boy usually work together. The man thrusts the spade into the ground at an angle, pushes the top forward — but not to and fro — leaving a wedge-shaped hole behind the spade, into which the boy places the roots of the plant. The spade is then withdrawn; the earth falls back on the roots of the plants and is made firm with the foot, care being taken not to injure the crown. Plants should be set so that the crowns are level with the ground surface; if too deep the young, growing shoot may be damaged or may rot, and if too shallow the plant will dry out.

Machine Planting — For large acreages machine planting is almost a necessity, as it increases speed to a marked degree; also there is provision for watering. It is very doubtful, however, whether it would pay to purchase a planting machine for strawberries alone, except for quite a large acreage. If other transplanted crops, as well as strawberries, are being grown in a large way, a machine would be indispensible.

A planting machine is operated by a man and team with two persons sitting behind to do the actual planting. Skilled workers can set up to 25,000 plants a day if the soil and plants are in proper condition. The soil should be mellow and friable and worked down to a fine state of tilth. The plants should be free of old runners and dead leaves; also, they should be of uniform size and placed as evenly as possible in the planter trays. A steady team and careful driver are necessary, so that the pace will be right for the speed of the planters, and also that the rows will be kept straight.

In loose light soil the machine may not pack the soil firmly enough about the roots and an occasional plant may be left out; this must be remedied by a man following behind the machine, and pressing the soil firmer with his foot, filling in gaps, and also watching for any plants that are not at the proper depth.

SHIPPING PLANTS

Strawberry plants can be shipped long distances providing they are properly packed and are not too long in transit. They have been sent by parcel post from Ontario to the Pacific Coast with satisfactory results.

Method of Packing — Plants must have sufficient moisture around their roots to prevent drying out and the tops should be left open to the air to avoid damage from mould and rot. By packing damp moss (not wet) around the roots and making an open-topped package, these conditions are met very well for ordinary short-distance shipments. For shipping long distances, however, it is advisable to take extra care in packing. Considerably more moss should be used so that it will retain sufficient moisture for the longer journey. Also, it is a good plan to wrap moist wood fibre around the crowns and tops of the plants. This makes a firm package, without being too compact, and allows air to circulate more freely around the tops and crowns of the plants, thus helping further to check the development of mould and rot.

Plants are usually tied in bundles of twenty-five, and wrapped in oiled paper, leaving the top open. Several of these bundles may be packed together in heavy nursery wrapping paper, again leaving the tops open.

Larger lots of plants may be packed in baskets, cartons, or boxes of proper depth, using the same packing materials. To prevent plants from being displaced the top of the container should be covered, either with slats or with a coarse open-mesh material, which will allow free passage of air to the tops.

When strawberry plants are moved in large lots, for comparatively short distances, they may be packed close together in boxes or bushel hampers or even on the floor of a truck, without packing material except for a little moist earth around the roots, provided they are protected from sun and wind by sacking or by a tarpaulin. They should be planted as soon as possible after digging, or at least heeled in until planting can be done; this recommendation applies no matter how they are packed and shipped.

CARE OF YOUNG PLANTATION

Cultivation and Weeding — Frequent and thorough cultivation is important. It should begin when the plants are set and should continue throughout the summer and fall to keep down weeds and to maintain a mellow soil condition. Early cultivation may be comparatively deep, but, as the season advances, it should become shallower so that the shallow-rooting system of the newly formed plants may not be disturbed. It is a good practice to run the cultivator in the same direction on each row so that runners may be trailed into position along the row, this also helps to prevent the dragging out of newly-rooted plants.

Hoeing close around the young plants, but not deep enough to loosen the roots, is necessary to destroy young weeds and to keep the soil in a mellow condition near the plants. It is important that this early weeding be done thoroughly because, once the young runner plants begin to root, it is difficult to hoe around them without disturbing the runners. If weeds continue to come up, much hand weeding will be needed adding greatly to the cost of production, hence the emphasis on using clean land for strawberries.

2, 4-D Weed Killer — This weed killer is being tried in strawberry plantations with more or less promising results. Some recent work at Michigan State College shows that small weeds, up to two or three inches, can be killed at low enough strengths to avoid injury to strawberry plants; in this particular work it was used at half the commonly recommended strength. Timing of application is important, as the flower buds and open flowers are sensitive to this material. In the first year it may be applied at any time, but in the fruiting year it should not be put on until after harvest. This latter application will not be necessary unless the plantation is being cleaned up for a second fruiting season. The 2, 4-D, being selective, does not kill grasses and grains, which sometimes are very troublesome in strawberry plantations.

There is considerable work to be done on susceptibility of strawberry varieties to 2, 4-D injury, and on strengths that may be used with safety on the more susceptible ones before general recommendations can be made.

Thinning and Spacing — Some strawberry varieties produce many more runner plants than are required for a good row, resulting in overcrowding and poor development. Actually, there is too much competition for moisture and food materials for plants to attain their fullest cropping capacity. This is particularly true of such varieties as Dunlap and Blakemore. The obvious remedy is the removal of excess plants and the spacing of those that are left, so that the ground is evenly occupied without crowding. Spacing of four to six inches between plants is suggested as a suitable distance.

Whether the extra labour and cost is actually worth while for a commercial plantation is a point the grower must decide for himself. There is, however, evidence to show that thinning and spacing of the Blakemore variety, in the South-Eastern States, is a paying proposition.

Some varieties, notably Valentine, make comparatively few, but large plants — sufficient to make a good row — and so do not need to be thinned, although some spacing would be advantageous.

Blossom Removal — As blossoming and fruit production are a considerable drain on the energy of a plant, it is good practice to remove all blossoms during the first year. It can be done when hoeing and weeding, although the writer prefers to do it as a separate operation. The plantation should be gone over several times, as all blossom clusters do not open at once, and the work may be considerably speeded if whole clusters are pinched out rather than individual blossoms.

Drainage Furrows — If there are any low places in the strawberry plantation it may be advisable to plow furrows in the fall to take away

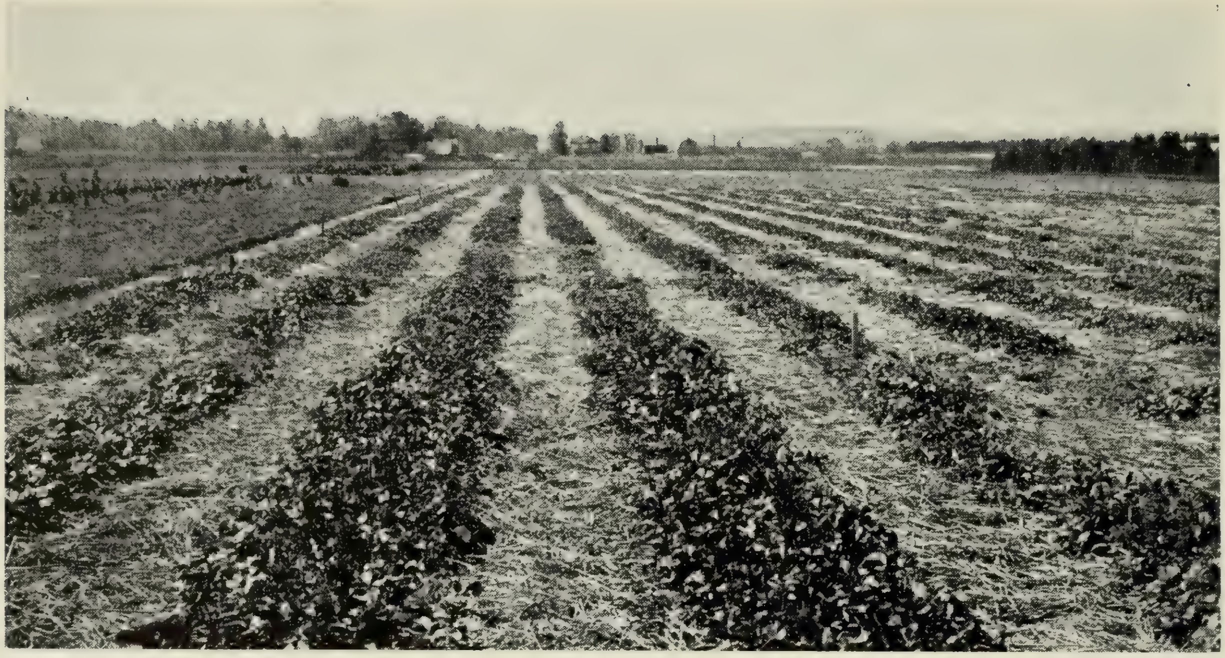

Fig. 9. Mulching. In winter the mulch protects the plants from injury by low and fluctuating temperatures. In summer, placed between the rows, it conserves moisture, keeps the fruit clean.

excess surface water that may accumulate in the spring. If soil erosion is likely to be serious, then probably it will be better to omit plowing drainage furrows and sacrifice a few strawberry plants; or to refrain from planting in the low places.

MULCHING

Reasons for Mulching — Strawberry plants are sometimes injured by extreme cold in winter and by heaving in the early spring due to alternate freezing and thawing. Also, crown injury may result from severe freezing in early winter, especially following a mild, moist fall, particularly if there is no snow cover when severe freezing weather occurs. To counteract the effects of adverse weather conditions, it has long been the custom to apply a winter mulch, which to some extent takes the place of snow cover and also helps to hold the snow when it does come. Incidentally, a winter mulch becomes a summer mulch which aids in keeping the fruit clean.

Recent Minnesota investigations indicate that the problem of winter injury is at least partly one of carbohydrate supply (sugars and starches) in the plant during the winter period; more particularly it is the effect of fluctuating winter temperatures on these carbohydrates. It appears that the "breathing" of the plants is more rapid under fluctuating temperature conditions than under constant temperatures even though the latter may actually average higher. The accelerated breathing uses up the carbohydrate reserves, weakening the plant. The mulch, by maintaining more uniform temperatures, conserves the vital carbohydrate supply.

Materials to Use — Wheat straw, rye straw, marsh hay, and strawy manure are all used as mulching material. Oat straw also may be used, but this may pack down too closely. Old hay is suitable, also shavings, and good results are reported from Nova Scotia on the use of sawdust. Any mulching material likely to contain weed or grain seed should be placed in loose piles out in the rain and sun for a month or two before it is needed, so that these seeds may germinate. Many seeds may be removed simply by thoroughly shaking out the material before using it.

The quantity of mulch to use will depend very much on climate and snowfall. Where low winter temperatures prevail or where there is little snow cover, a heavier mulch will be required than where temperatures are more moderate, or where there is ample snow which comes early and stays throughout the winter. From two to four inches of mulch, when settled down, should be sufficient. This should be spread evenly over the plants but it is not necessary to cover the ground between the rows.

Source of Material — On high-priced fruit and market-garden land it is more economical to buy mulching material than to attempt to grow it. On cheaper land it can be grown on the place to save the cost of buying.

Time of Application — At one time it was recommended that mulch should be applied in early winter as soon as the ground was frozen hard enough to support a loaded wagon. More recently, however, it has been found that injury may occur considerably earlier, particularly to the crown, hence earlier application is now recommended. It is advisable to have material in readiness for spreading so that it may be applied when severe weather threatens. The time will vary with locality and season, but it is usually towards the end of November or early December in the milder parts of the Province, and earlier where winter sets in sooner. However it should not be applied too soon, as the plants need to acquire some degree of hardiness by being exposed to light frosts.

Mulch Removal — The mulch is removed in early spring, usually about the middle of April or when new leaves are just beginning to show under the mulch. If left too late, injury to the plants may result but the main objection to leaving it on too long is that blossoming and fruit ripening may be delayed. In some localities the resultant delay in blossoming time may be an advantage on account of late frosts. Also, where plants are grown for sale, the mulch is usually removed as digging proceeds so that the digging season may be lengthened.

The mulching material may be removed entirely, (except to leave some close in around the plants), in which case cultivation between the rows will be necessary; or it may be left between the rows where it will help to keep down weeds, hold moisture, and prevent soil splashing on the fruit during heavy rains. Leaving it between the rows is usually preferable, but all the ground should be well covered so as to smother weeds.

RENEWING THE PLANTATION

The practice of taking a second crop from a plantation, or renewing, is favoured by some growers, although it is generally conceded that it does not pay unless the plantation is in good health and vigour, and reasonably free of weeds at the end of the first fruiting season. The second crop is apt to be lighter but somewhat earlier than the first. Insects and diseases are likely to be more troublesome on the older beds. Wherever root rot is prevalent it is not advisable to try to take off more than one crop, as affected plants do not make good growth. In fact, many growers have given up trying to get a second crop on account of root rot. Plowing under after the first crop and practising a long rotation, five years, are helpful controls.

As soon as the fruit picking season is over the renovating process should be carried out. It is first necessary to cut down big weeds and remove them, along with the mulch, from the plantation. The rows can then be narrowed down to one-half their width by plowing one or two furrows off one side, leaving the other half of the row to produce new plants. This remaining half row should be cleaned up by hoeing out weeds and excess plants. If clumps of plants are left every eight or nine inches, enough new plants should form to make a good row.

The spaces between the rows should now be well cultivated to clean out weeds and level the soil; at the same time well-rotted manure should be worked into the soil to stimulate plant growth and encourage the formation of new runner plants. If the ground is well supplied with organic matter the manure may be omitted, and some good commercial fertilizer, or nitrogen alone, may be used instead.

As an alternative to the more conventional way of cleaning up a strawberry plantation for a second crop, a few growers are beginning to use the weed killer 2, 4-D. One man has found that two applications, about three weeks apart, of 2, 4-D, not exceeding in strength 1200 parts per million, applied during July and August, will kill most of the weeds, but that there are a few, including grasses, that it does not touch. Along with this treatment shallow "rotary" tillage between the plant rows will break up the mulch and mix it with the top-soil thus improving its tilth and avoiding the labour of removing the mulch. Also, well-rotted manure and fertilizer can be worked into the soil at this time.

IRRIGATION

Undoubtedly the largest single factor affecting yield is that of moisture supply preceding and during the picking season. Richness of soil is of little value if moisture is not present in sufficient amount. A plentiful supply of organic matter certainly makes the soil more retentive of moisture, but does not add any to it.

Prolonged dry spells are causing growers to consider the possibilities in irrigation. Timely irrigations in some seasons may mean the difference between a good crop and practically no crop at all. Usually the main purpose of irrigation is to supply water while the fruit is developing and ripening, but if the young plants are not making good growth in the year of planting due to drought, an occasional watering would be of great benefit.

There is some danger of applying water so freely that the fruit will be soft with consequent poor shipping and keeping quality. The aim should be to apply enough for the plant's needs without overdoing it. Two or three thorough waterings would be more effective than a greater number of lighter applications.

Whether irrigation for strawberries will actually pay in dollars and cents depends very much on a grower's circumstances. Cost of installation, distance from water supply, crop and price, will all have a bearing on the profitableness of the venture. It is doubtful if an expensive sprinkling system will pay if used for strawberries alone, but if other crops which are benefited by irrigation are grown it would be more likely to pay.

Probably the cheapest system is that of plowing furrows between the rows for water distribution, but this calls for a large supply of water, and involves careful grading of the land so that water may flow freely and steadily over the whole plantation. With this system, however, there is considerable danger of soil erosion, particularly if there is too much slope to the land. Also, on the lighter, sandy soils, water does not flow freely enough, so that it is not evenly distributed.

Of late years what is known as the porous-hose system has come into use. It consists of canvas hose through which water can ooze along its entire length. Water is delivered to it by means of ordinary iron pipe or rubber hose, and connections are made by suitable couplings. A terminal cap prevents the water from running out at the end. The hose is laid between the rows of plants and may be moved about as required. A length of 300 to 400 feet is about as much as can be handled conveniently. Shorter lengths may be better, as it is rather awkward to handle when wet and muddy. When storing away at the end of the season, it must be cleaned and dried carefully or it will rapidly deteriorate.

PICKING AND MARKETING

The picking and marketing of the fruit is often the biggest problem that the grower has to face. Where only small acreages are grown, the necessary assistance for picking can usually be obtained from a grower's own family and from his neighbours or nearby villages. When large acreages are grown other provision must be made for picking. The pickers must be on hand when the fruit is ready, so they must be engaged early in the season.

On well-managed fruit farms the work is fairly continuous from spring to fall. Extra help is usually taken on as the season opens up, for such work as planting strawberries, tomatoes and other crops, weeding, fruit picking, etc., but this help often has to be supplemented by extra hands for the height of the strawberry picking. Families of Indians and Japanese often are engaged for this work and are housed on the place. With a little training, they make satisfactory pickers, especially the women and girls. Casual workers also are often used.

Considerable supervision of pickers is necessary to ensure careful and clean picking. The fruit should be picked off by the stems and not pulled off the plants; also, not more than two or three berries should be held in the hand at a time as they are very easily damaged.

The berries are ready to pick when they are from three-fourths to all red; they should not be allowed to get over-ripe. If over-ripe and dry, they sour, and if over-ripe and damp they mould and rot. On the other hand, green berries do not ripen after picking and detract very much from the pack if mixed with ripe fruit. The best growers pay considerable attention to grading and packing, as they find it pays to put up an attractive and honest pack.

YIELDS AND RETURNS

Yields vary so much with individual growers, and according to soil and locality, that it is difficult to state quantities that mean very much. The average yield for Ontario, west of Toronto, in 1946, was slightly in excess of 2,150 quarts per acre; a good yield would be from 5,000 to 7,000 quarts per acre.

Returns per acre depend on many factors apart from price fluctuations. Price of land, availability of labour, and yield particularly, are major factors in determining what these returns may be to the grower. Cost of production is just as important as price. On expensive land high yields and good prices are essential to profitable production, but on low-priced land these factors may not be quite so important. In any case costs must be kept as low as possible, without sacrificing good cultural practices.

EVERBEARING STRAWBERRIES

Culture of the everbearing strawberries is very similar to that of the ordinary kinds. As a rule they are set out in spring as early as the condition of land and plants will permit. If weather conditions are favourable, they may also be planted in the fall. This should be done early enough — usually by mid-August — for them to become established before winter sets in. They are then ready to start growth in spring as soon as conditions are favourable, and so have a better chance to make good strong plants by early fall.

Blossoms are picked off until about the middle of July. Later blossoms will produce a crop the same fall. The following year an early summer crop may be obtained and also a second, or fall crop, after which the plants are discarded.

Everbearers are expected to do a great deal in a short time; so, everything possible must be done to promote growth and fruit development. This implies a fertile soil, rather better than ordinary strawberry land with a plentiful supply of humus which will retain moisture during dry weather. Also, the best of care in planting, hoeing and cultivation must be given. A poor soil and lack of moisture will result in weak plants with poor-sized fruit. In many seasons irrigation may be the deciding factor in the successful growing of everbearing strawberries.

If the organic-matter supply is somewhat deficient, it must be built up by generous applications of manure, 20 to 30 tons per acre. It is best to apply the manure the year previous to planting strawberries, so that weed seeds therein may be encouraged to germinate well before planting.

Everbearing strawberries usually form fewer runners than the June-fruiting sorts. They may be grown either in hills or matted rows. Under the hill system, any runners that do form are removed and, for this method, plants may be set 12 to 15 inches apart in the row, with rows 36 inches apart. For the matted row, runners are allowed to grow and form a wide row, so that the mother plants should be at greater distance, usually 15 to 18 inches in the row with rows 42 to 48 inches apart.

Gem and Mastodon are the varieties most commonly grown in Ontario. Gem is hardier than Mastodon and is a better plant-maker.

There is no problem of winter mulching if the plants are set in the spring and plowed under after the fall crop as then they are simply grown as an annual crop. However, if they are kept over for a second crop, or if planted in the fall so that they have to go through a winter, a winter mulch is advisable. This may consist of straw, strawy manure, or hay, and a light covering three or four inches thick will be sufficient. It should be put on before severe freezing weather sets in. A summer mulch is also desirable, as it is the only way that fruit can be kept clean during heavy rains.

Everbearers do not yield as well as the summer-fruiting sorts but have a place for special markets. Also they may be of considerable value in places subject to late spring frosts as the early blossoms may be killed but there will be others to come on during the later part of the season when danger of frost is past.

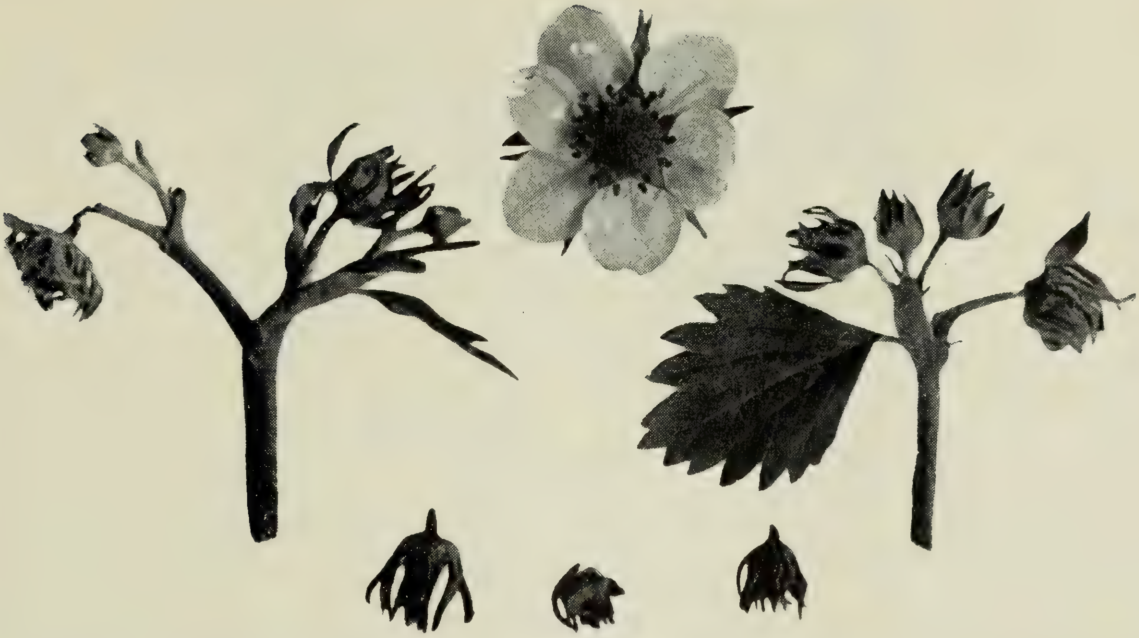

Fig. 10. The strawberry weevil chews the stems of blossom buds, which causes the buds to wilt or drop to the ground.

(Courtesy of W. A. Ross.)

INSECTS AFFECTING STRAWBERRIES

H. W. Goble, Dept. of Entomology, O.A.C., Guelph

The chief insects affecting the strawberry are: the strawberry weevil, spittle bugs, white grubs, cutworms, strawberry leaf beetle, and strawberry leaf roller.

The Strawberry Weevil (*Anthonomus signatus* Say.)

This is a small, reddish-brown snout beetle from 1/12 to 1/8 inch long. The work of this insect causes the blossom buds in spring to wilt and hang on partly severed stems, or to drop to the ground (see illustration). Occasionally as high as 70% of the blossoms may be destroyed in this way, and the crop thereby greatly reduced. The insect is not injurious in most plantations and outbreaks are most likely to occur in patches with rough headlands or adjoining waste or wooded areas, because these afford excellent winter quarters for the beetles.

Control — (1) Clean farming and clean surroundings. For the reason mentioned above, strawberries, if possible, should not be planted near woods or waste land, and, as the adults may winter also under rubbish or dense weeds and grass in or alongside the strawberries themselves, the plantation and its adjacent surroundings should be kept as clean as possible. New plantations should be set as far as possible from old ones.

(2) Spraying or dusting: DDT dust or spray has given good control of this weevil. As a spray, use 2 lb. of 50% DDT wettable spray powder to 100 gal. water. If control of leaf spot is also required, add the same amount 50% DDT to Bordeaux 5-7½-100. When using Bordeaux add the DDT last to the spray tank. If dusting is preferred, use 3% DDT. Do **not** add DDT to copper-lime dust. Application should be made when the earliest blossoms appear, which is the time for the second spray for leaf spot.

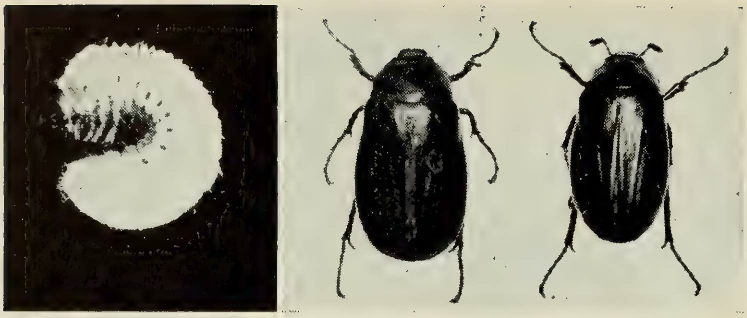

Fig. 11. White grub and adults — June beetles.
(Courtesy of J. Marshall.)

SPITTLE BUGS

These insects are readily recognized by the presence of spittle-like masses on the leaves, flowers, or stems of the strawberries. As soon as the eggs hatch, the nymphs or young form a very small drop of frothy material which increases in size as the nymphs of the insects grow. There may be one or a number of insects in each spittle mass. Where plants are infested, spittle masses may still be found in the patch at picking time on both the leaves and fruit. These insects feed by sucking the juices of the plant. The spittle-like material is objectionable on the berries. The fruit may be reduced in size as a result of feeding by the insects.

Control — Spraying or dusting with DDT has given good control. The time and rate of application is the same as for strawberry weevil.

WHITE GRUBS (*Phyllophaga* SPP.)

Strawberries are very susceptible to injury by white grubs. These are the larvae of June beetles and are the same grubs (see illustration) which often attack corn, potatoes, and other crops planted in soil broken up from grass or timothy sod. They are much more common in light than heavy soil. The grubs require two seasons and a small part of a third to become full-grown. They have the habit of going down below the plow-line about October 1st for winter and coming up again near the surface during the early part of May. Hence, they may be present and yet not seen when plowing after October 1st and before May 15th.

A heavy attack of two-year grubs, the stage that causes most severe injury, is expected in 1948 throughout most of Ontario and if the cycle continues, would occur again in 1951. The exception is an area around Oshawa and extending west through Ontario, and the southern part of York, Peel and Halton Counties, also the Niagara Peninsula, where the main brood of two-year grubs was in 1947 and may be expected again in 1950. While there is more probability of injury in cycles listed above, injury may occur at other times.

Control — It is not safe to plant strawberries in land broken up from grasses or timothy sod until two years, or sometimes three, have elapsed, or unless by digging or plowing you have made sure no white grubs are present. Choose, instead, land on which vegetables have been grown the previous two years, or which has been under a short rotation of crops in which clover may have been one crop, and which has been kept practically free from grass. If the grubs are present and injuring the strawberries the only way to get rid of them is to dig them out and kill them.

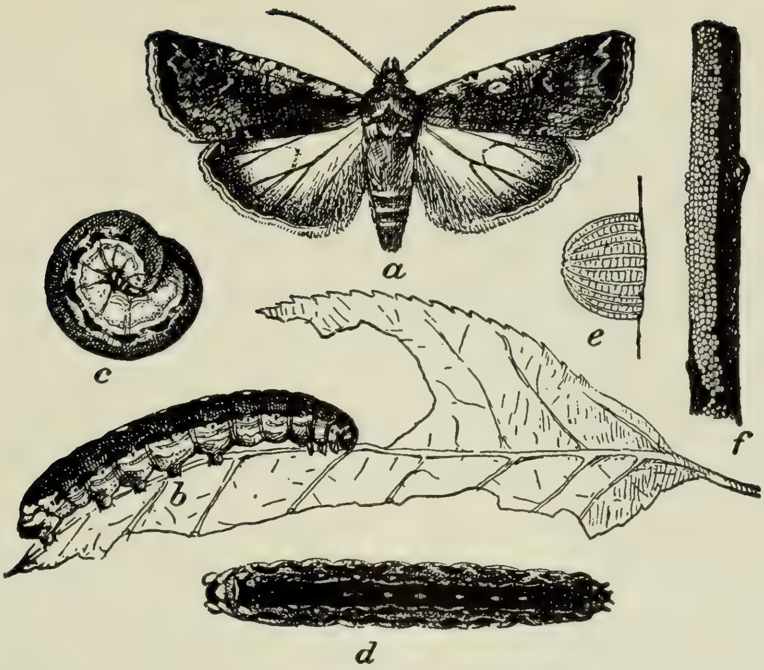

Fig. 12. Variegated cutworm — (a) moth; (b, c, d) cutworms themselves in various postures; (e) egg greatly enlarged; (f) egg masses on a stem (after Howard, U.S.D.A.)

CUTWORMS

Several species of these insects attack strawberries. They are stout, smooth, greasy-looking, dull-coloured caterpillars, about 1½ to 2 inches long when full-grown. The adults are stout, dull-coloured moths which fly at night. They are commonly known as "millers." The caterpillars attack the plants late in the evening and during the night and cut off the stems at the ground or eat the leaves. By day the cutworms lie curled up and hidden beneath rubbish, or just under the surface of the soil.

Control — By far the most common method is by the use of a poisoned-bran bait, a good formula for which is:

Bran	25 lb.
Paris green or white arsenic	1 lb.
Water enough to moisten the bran, or about	2½ gals.

Mix the bran and poison **very thoroughly** while dry, in a washtub or on a smooth concrete floor. Then pour the water gradually over the poisoned bran and mix until all is moist but still will fall through the fingers like damp sawdust.

Be careful not to allow livestock to get access to the mixture.

The bait should be scattered by hand, thinly, over the plants on a warm and preferably calm evening. The above amount should be enough for at least one acre. It should never be applied during the daytime as it would soon dry out and lose its attractiveness, nor should it be applied when temperatures are below 65° F., because the cutworms are not active and do not feed at low temperatures.

STRAWBERRY LEAF BEETLE (*Paria canella* FAB.)

Strawberries are occasionally attacked in spring and again in fall by small, stout, glossy brown or almost black beetles about 1/8 inch long. These eat small holes in the leaves, often completely riddling them. Their larvae are tiny white grubs which feed upon the rootlets of the plants, and some years do considerable damage. As a rule, neither beetles nor grubs are abundant enough to cause injury to justify control measures.

Control — If the beetles are seen in time in spring they may be held in check by careful spraying with either 5 lb. lead arsenate or 3¾ lb. calcium arsenate in Bordeaux mixture 5-7½-100. This must be applied before the blossoms open. It may also be used in fall if there are enough beetles to justify it. If the beetles are nearly all destroyed there will, of course, be too few grubs to cause appreciable damage to the roots in the succeeding years.

STRAWBERRY LEAF ROLLER (*Ancylis comptana fragariae* [W. & R.])

These insects were more plentiful in 1947 in some parts of Ontario. The larvae are small, greenish or bronze caterpillars, which roll the leaf or fold part of the leaf. They feed on the inside of the folded leaves and, when abundant, cause a plantation to look greyish instead of a rich green colour. The adults are small, brownish moths. There are two or three broods of larvae a year, and so injury may take place over several months.

Control — This insect is very difficult to control by spraying. DDT has shown little or no promise. Try to avoid an infestation by setting new plantings as far as possible from old. Pinch infested leaves to kill caterpillars when setting out new plants. Plow under old plantations after harvest if no further crop is to be taken from this patch. If the old patch is to be left for another year, cut tops with a hay mower as soon as the crop is harvested, rake and burn.

Spraying. Spray just before the blossoms open with 5 lb. lead arsenate or 3¾ lb. calcium arsenate in Bordeaux 5-7½-100. If the infestation is serious spray again after harvest, using the same mixture. Repeated application at 10-day intervals after harvest may be necessary if infestation is severe.

STRAWBERRY DISEASES

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The chief diseases of the strawberry in Ontario are black root, powdery mildew, leaf spot, leaf scorch, and fruit rot or grey mould. Yellows or yellow edge (xanthosis) and June yellows are also causing some losses to Ontario growers.

BLACK ROOT (ROOT ROT)

This is a very troublesome disease in many parts of the province and is causing a serious reduction of the crop in many plantations. It is apparently becoming more serious each year. It is often confused with, and complicated by, winter injury which makes the roots susceptible to attacks of soil fungi.

Symptoms — The most pronounced symptoms are usually observed when the berries are about half-grown. The diseased plants wilt, turn yellow and dry up. On examination, the roots of affected plants will be found to be black throughout with few, if any, healthy lateral roots. (See page 11.) Different soil fungi have been found capable of causing this trouble.

Control — No completely effective control of this disease has yet been devised. The following precautions, however, should do much to reduce losses from it. Use only healthy planting stock. Get stock, if possible, from a plantation free from black root. Plants should be set out as soon after digging as practicable. Good drainage is essential in the control of this trouble. A rotation of crops is of utmost importance. If the disease has been serious, a five-year rotation is advisable, that is, strawberries should not be set on the same soil oftener than once in five years. A soy-bean cover-crop preceding strawberries has been found beneficial. Follow cultural practices that tend to produce strong, vigorous plants, such as careful mulching to protect plants from winter injury, the plowing under of cover crops, and the judicious use of commercial fertilizers.

POWDERY MILDEW (*Sphaerotheca humili* [FRIES] BURR.)

This disease causes trouble from time to time in the province.

Symptoms — The leaves of affected plants curl upwards as though from dry weather, exposing the under side of the leaves, on which will be seen the characteristic white, powdery fungus. In severe attacks, the leaves become dry, the plant may be completely destroyed, and the crop rendered useless.

Control — At the first appearance of mildew, dust the under surfaces of the leaves with sulphur or with 15-85 copper-lime dust. Repeat applications at two-week intervals, if necessary. Use the dust at the rate of not more than 50 lb. to the acre, and do not apply in very hot weather.

LEAF SPOT (*Mycosphaerella fragariae* [SCHWEINITZ] LINDAU)

This disease has become of comparatively little importance in Ontario as many varieties now grown are very resistant to it. It occurs now chiefly in plantations in which certain of the older, more susceptible varieties such as Glen Mary and Parsons are still being grown.

Symptoms — Spotting of the leaves is the conspicuous symptom. These spots are reddish or purplish at first. Later, as they enlarge, the centre becomes ashy white, bordered wih red or purple. In severe attacks the spots are numerous and close together, severely injuring the foliage and reducing the yield.

Control — Spray with Bordeaux mixture 5-7½-100 when the growth is well started and again when the first blossoms appear. Glen Mary and Parsons are susceptible to this trouble. Premier is resistant. Plants with healthy foliage only should be set out. Spotted leaves should be removed. The plantation should be cropped for two seasons only, then plowed down.

N.B.—If either strawberry leaf beetle or strawberry leaf roller is also giving trouble, add 5 lbs. of lead arsenate or 3¾ lbs. calcium arsenate to each 100 gallons of the Bordeaux. If spittle bugs or strawberry weevils are prevalent, add 2 lbs. 50% DDT wettable spray powder to each 100 gallons of the Bordeaux, applied at the time when the first blossoms appear.

LEAF SCORCH (*Diplocarpon earliana* [ELL. AND EV.] WOLF)

This is another leaf-spot disease of strawberries. The spots become large, conspicuous, dark-red or purplish blotches, and in severe cases the leaves curl and dry up. So far as the grower is concerned leaf spot and leaf scorch may be considered as one, as the same remedial measures apply.

FRUIT ROT OR GREY MOULD

In wet summers much fruit is often ruined by this mould. It affects both green and ripe berries. They become rotten and covered by a grey, powdery mould.

Control — Dust with sulphur or 15-85 copper-lime dust. Give repeated applications if the weather is wet. After the fruit begins to ripen apply these, if possible, immediately after each picking. Do not apply sulphur dust in very hot weather.

YELLOWS, YELLOW EDGE (*Xanthosis*)

This is a virus disease of strawberries which is attracting the attention of strawberry growers in Ontario. In some plantings it has caused considerable loss. It is spread by means of aphids.

Symptoms — In general, the affected plants are dwarfed and somewhat yellow especially around the margins of the leaflets. Frequently the leaflets are green in the centre with the edges yellow. Infected plants never recover and all the runners they produce will be diseased. The symptoms vary considerably with the variety affected and are influenced by temperature. High temperatures during the summer tend to obscure the symptoms which become pronounced again during cool fall weather.

Control — Select planting stock from yellows-free plantations. Set new plantings at as great a distance as practical from old infected ones. If aphids are abundant in the early spring, American authorities advise that the setting out of new fields be delayed until the aphids have disappeared, which, it is claimed, they do in the late spring or early summer.

Roguing abnormal plants during the first summer in new plantings will help, but is not considered practical after the first season of growth.

JUNE YELLOWS

This is a disease which will not spread in the field. It is characteristic of some varieties. The tendency to it appears to be inherited by some varieties. It has been noticed in Ontario for several years but considered of minor importance until the introduction of Premier and Blakemore, in some strains of which it develops to a marked extent. It is also seen in many everbearing varieties.

Symptoms — Yellow streaking and mottling of the leaves is the most striking symptom. In the early stages the young leaves show a faint streaking and mottling of yellow or cream and green. As the affected leaves develop, the green colour diminishes and finally the leaves become golden or light yellow with little or no green. Badly affected plants become stunted and produce but little fruit. Diseased plants never recover though they may remain alive for two or three years. All the runner plants they produce become affected.

Control — Select planting stock from yellows-free plantations. Certain strains or stocks of Premier and Blakemore are reported as comparatively free from this trouble. If possible, such strains should be used.

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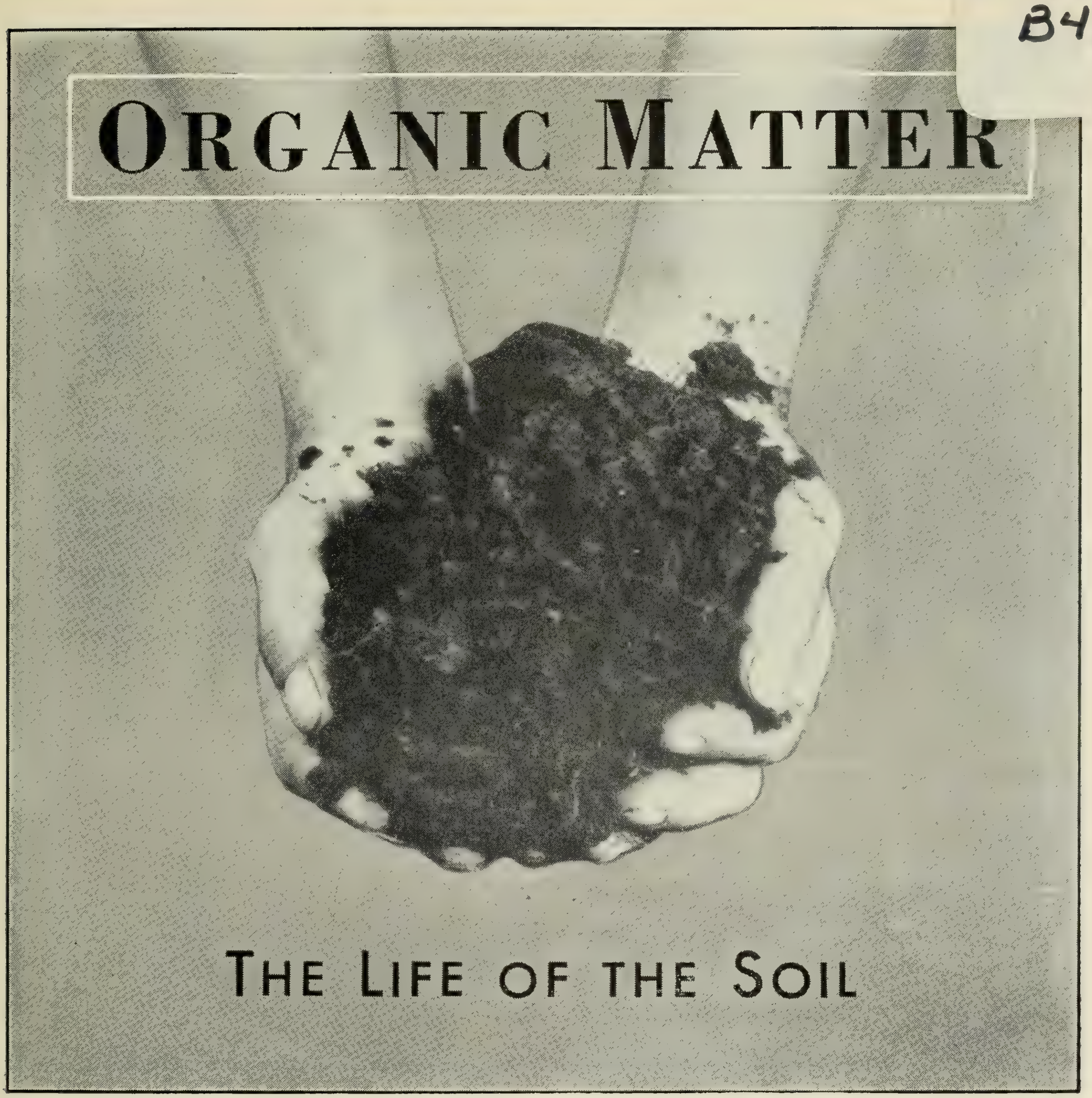
ORGANIC MATTER



THE LIFE OF THE SOIL

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ONTARIO DEPARTMENT of AGRICULTURE

STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 459 JUNE, 1948

ORGANIC MATTER

CAN PUT LIFE BACK INTO YOUR SOIL!

A soil without organic matter, or fibre or humus, is a **dead** soil. All soils contain **some** organic matter, but some farm soils contain **so little** that they are perilously close to exhaustion and ultimate death. ***This has resulted from over cultivation and cropping, with failure to put enough organic matter back to keep up sufficient reserves in the soil.*** The capacity of a soil to produce crops is gradually lowered as its organic matter content is reduced. As the soil's productive capacity decreases, less organic matter, in the form of crop residues, manure, etc., is available to be returned to the soil. Thus, a vicious cycle sets in—poor crops to leave less organic matter; less organic matter to leave poorer soil. Is it any wonder, then, that finally, the tired, run-down, worn-out soil gives up and refuses to produce a crop at all?

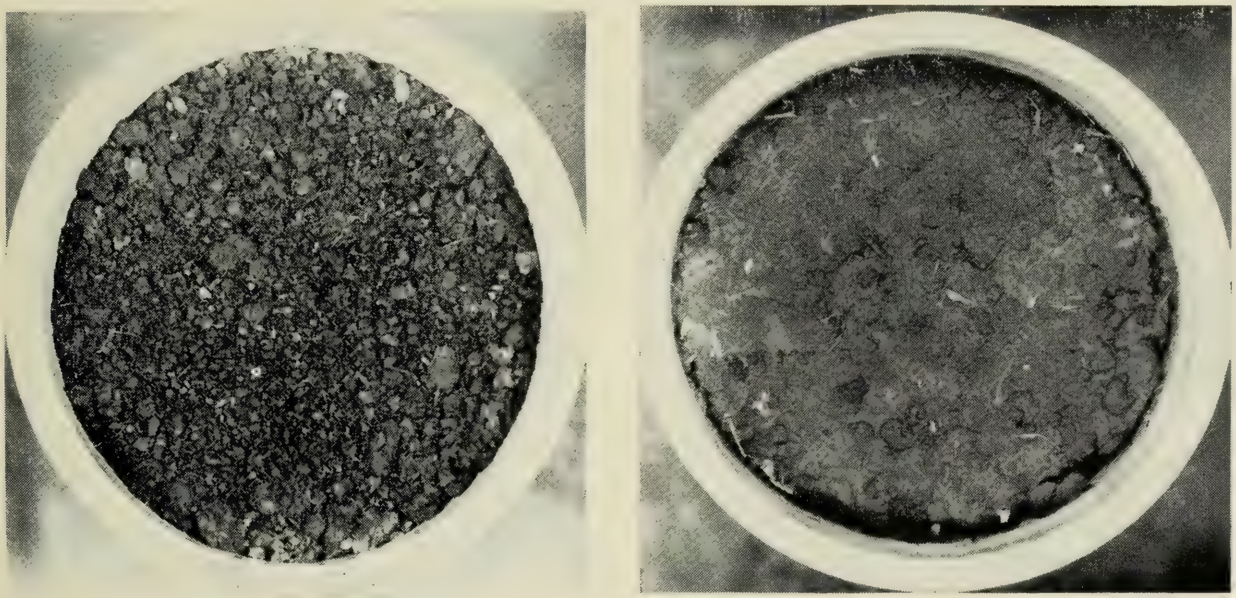
This is not just idle theory! This depletion has already happened on farms in the midst of what we term the best agricultural areas of this Province. It is happening even now on more farms through misuse of the land. The prosperity of our farms depends on their continuing capacity to produce good crops. Soil depletion undermines and destroys the very foundation of our agriculture. We cannot afford to further exploit our soil resources for the sake of immediate gain, or because of indifference for the future. It is in our present interests to become aware of the soil conservation problem and then actually to do something about it.

Fortunately for all of us, it is **not** too late or too difficult to solve the problem of building up and maintaining adequate levels of organic matter in our farm soils. This leaflet discusses the overall problem in some detail and points out the various practical means by which organic matter and humus may be restored to the soil. No one method alone is likely to be adequate by itself, or equally well suited to all types of farming, but it should be possible to utilize a combination of practices on every farm that will accomplish the desired end. This may require some major changes in present rotation and soil management practices, but it is well to remember that nothing worthwhile was ever accomplished without effort. Organic matter maintenance is part of good farming and good farming doesn't "just happen", it comes from **"planned effort"**. We need to plan the work and then to work the plan!

HOW SOIL ORGANIC MATTER BECOMES EXHAUSTED IN CULTIVATED SOILS.

The organic matter or fibre of soils is the source of food and energy for millions of bacteria and fungi which flourish in its presence and are essential in a fertile soil. Just as the food we eat is **"burned"**, (oxidized), in our bodies, to provide us with materials for replacement of tissue, and energy for our work, so organic matter is slowly **"burned"**, (oxidized), in the soil to provide replacement of humus and to give readily available nitrogen and minerals for the soil microbes and crop plants. Oxygen from the air is necessary for both processes, and the more oxygen taken into the body, (by breathing), or into the soil, (by absorption), the more rapid the burning process goes and, and more food or organic matter is used up.

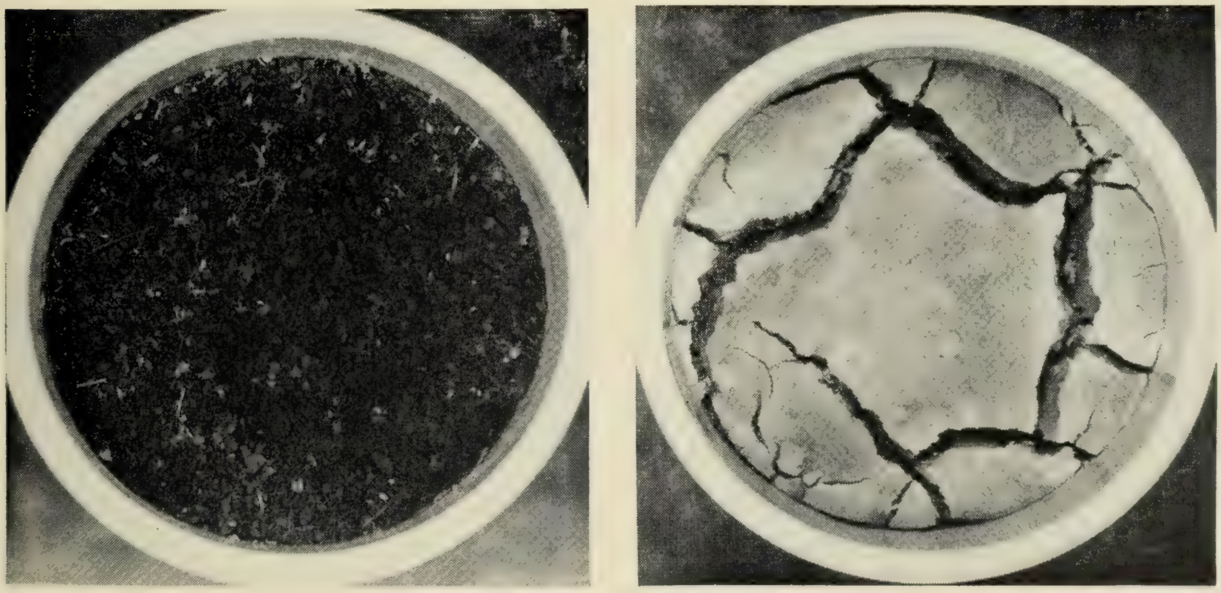
The more you **cultivate** and stir any soil, the more air and oxygen enters the pore spaces, and speeds up the oxidation or "burning-up" of the organic matter by the soil microbes. Cultivation and stirring of the soil are like opening the drafts and stirring the fire in a coal or wood-burning furnace. The fire burns faster, and if you want to keep it from going out, you have to (a) keep adding more and more fuel as fast as it burns, or (b) close the drafts and add only a little fuel occasionally to keep the fire alive.



ORGANIC MATTER IS THE KEY TO GOOD SOIL STRUCTURE.

This soil has been in sod for years, hence is well supplied with organic matter, and has an open crumb-like structure that is not broken down even by beating rains.

Originally similar soil to that on the left, but from an adjoining field where the organic matter has been depleted by faulty management and the physical condition is very poor. You don't dare work this soil right after rains.



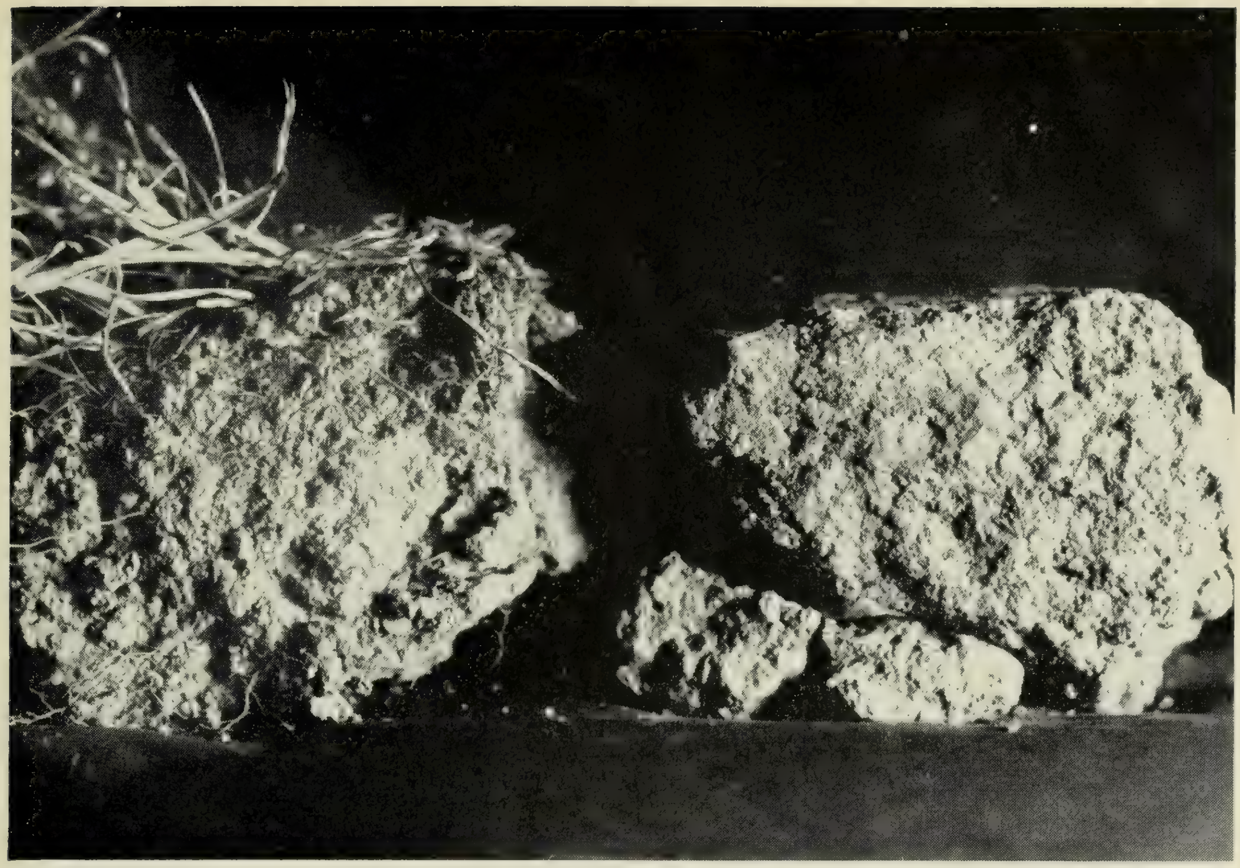
This well granulated, humus rich soil, when wetted, absorbs the water readily, drains freely, yet acts like a sponge to hold a store of moisture for the crop when it needs it.

When rain hits this soil, the top layer runs together like slurry. After the sun has baked it for a few hours it sets like concrete, and then cracks into blocks. When heavy soils are exhausted of their organic matter they are "balky" soils to work, wet or dry.

When we grow only clean cultivated, row crops like corn, sugar beets, tobacco, beans, etc., in a rotation, we keep the drafts on our soils, 'wide-open', and organic matter is being burned up continually, and at a very rapid rate, as compared with a rotation in which only one clean cultivated crop occurred in a 4 or 5 year period. Further, where these clean cultivated cash crops predominate in the rotation, and little livestock is kept on the farm, little manure is made for the land. If, in addition, crop residues like cornstalks, and straw, are burned on top of the ground to get them out of the way, **the robbing of the soil, of organic matter return from crop residues, is just about complete!**

Fundamentally then, this is the matter in a nutshell. We have created this organic matter problem ourselves by,—

1. Growing too many clean cultivated row crops in succession, year after year, giving the soil no rest.
2. Discarding clovers from our rotations for more "profitable" crops.
3. Not having enough livestock manure available for even occasional dressing of land under row crop.
4. Having no sod crops, (or soil-building crops) in the rotation.
5. Burning straw stacks and cornstalks "to get rid of them".
6. Cheating the soil by not even growing an occasional green manure crop for plowing under.
7. Putting less plant food back into the soil than we were taking out!
8. Forgetting that Nature is violently opposed to "clean cultivation" in the way it has been practised to the extreme in the past.



The soil on the left, from a sod field, has a good crumb-like structure because of the abundance of root fibres and organic matter it contains.
The soil on the right is from the next field after three successive corn crops. It has lost its fibre and granular structure, and has become compact, massive and solid, like a pavement. Which would you prefer to have to fit for the next crop?

WHEN ORGANIC MATTER GOES OUT SOIL BREAKDOWN SETS IN!

In heavy textured soils, clay loams and clays, the organic matter content is especially important because it greatly influences their physical properties, drainage and aeration. Sufficient active organic matter is necessary to give to heavy soils what we call a **good structure.** Now a soil has a good structure when the particles, or grains, are grouped tightly together in **clusters,** or **granules.** Such a soil has a granular structure. Farmers know that a granular structure is good. You can find this granular structure if you take a handful of topsoil from beneath an old grass sod. The granules look like bread crumbs; in fact we speak of this as **crumb** structure. Such a crumb structure makes for plenty of pore spaces in the soil, through which surplus water can drain out, and air can get in to the plant roots.

When organic matter is worked out of a soil, these crumbs are **broken down,** the soil particles become separated by raindrops falling directly on the surface. The fine particles run together, clog the pores, and form a seal over the surface, that prevents normal absorption of surface water. Thus the surface water is prevented from soaking into the clayey soils and getting into the tile drains, where it should go. ***Gradual failure of tile drains to work satisfactorily in heavy soils, even when spaced at close intervals, may be traced to the breakdown of good structure in the topsoil through excessive cultivation and failure to maintain organic matter.*** This destruction of the structure or physical condition of heavy soils is indirectly responsible for their lowered productivity. It is also the cause of greater difficulty in tillage. With loss of organic matter, and a breakdown of the crumb structure, the soil becomes more plastic and sticky

Note how the sweet clover roots extend through the plow layer into the subsoil. For rebuilding organic matter and fertility, improving drainage and aeration of ***both topsoil*** and ***subsoil***, sweet clover is one of the topnotch legume organic matter crops.

when wet, puddles more readily if worked at too high a moisture content, and on drying, bakes into massive blocks or large clods which are pulverized only with great difficulty. Buying bigger and faster tractors and more powerful tillage machines does not really solve this problem. The true solution lies in restoring the desirable granular or crumb structure of the soil, through building-up and maintaining organic matter and fertility. Putting first things first, is the principle to be applied if the soil is to be rehabilitated, and its productivity restored.

Crop residues should not be burned but should be plowed under to return organic matter and fertility to the soil.

RESTORING ORGANIC MATTER TO THE SOIL.

The first step towards the practical solution of the organic matter problem is to sit down and take stock of your past cropping program. In following a crop rotation, the farmer grows several crops in a planned order: **he doesn't grow the same crop year after year, on the same piece of land.** He knows that growing a cultivated crop year in and year out will make his soil poor in spite of everything. So he plans a balanced rotation—balanced with respect to soil conserving and soil depleting crops. For example, intertilled crops, corn, tobacco, sugar beets and tomatoes, are considered to have a soil depleting effect of −2 per cent on soil productivity. Soybeans, as hay or seed, (straw not returned), have a −0.5 per cent effect on productivity. If cornstalks or soybean straw are returned to the land, their depleting effect is reduced by 0.25 per cent. Grain crops, (wheat, oats, barley), have a depleting effect rated at −1.0 per cent. When combined and the straw is left on the land for incorporation into the soil, the grain crops then are considered to have a less detrimental effect, and are rated only −.75 instead of −1.0.

Alfalfa is an excellent source of high-nitrogen organic matter for plowing under in either light or heavy soils. Don't cheat—plow under the *whole* crop.

With the soil conserving crops, on the other hand, plus values are assigned for their beneficial effects on the soil. When cut for hay or grazed, alfalfa, (seeded 1 year before), has a value of +2.5; red clover, (seeded 1 year before), a value of +2.0; mixed red clover and timothy, (seeded 1 year before), a value of +1.25; timothy alone, a value of +.25 per cent. Thus it is seen that legume crops and sod crops in a rotation are most important for the contribution they can make to organic matter supplies and the improvement of soil structure. Experiments and experience have shown that a well fertilized sod of grass and clover, or alfalfa and grass, will supply as much organic matter as a liberal application of manure.

Organic matter and the nitrogen content of a soil are directly related, the former being about twenty times the amount of the latter. The loss of organic matter from a soil involves the loss of nitrogen as well. To build up organic matter requires the building-up of nitrogen at the same time. This fixed relationship of nitrogen to organic matter gives the legume crops, (clovers, alfalfa, etc.), an especially important place in the rotation. When the roots of these crops are inoculated with notrogen-fixing (nodule) bacteria, they are able to use nitrogen from the atmosphere. Thus when **inoculated** legume crops are plowed under, they **add** nitrogen as well as organic matter to the soil, and speed up the rebuilding process. Where harvested for hay or pastured and only the roots and stubble are incorporated, it is considered that the nitrogen of the soil is just maintained. When harvested for seed and the legume straw is left on the sod to be plowed into the soil, there is an appreciable addition of nitrogen to the soil's supply, but not quite as much of course as where the whole crop is plowed under.

CROP RESIDUES SUPPLY ORGANIC MATTER.

Straw, cornstalks, tomato vines and beet tops and other residues, when left on the land to be plowed under or disced into the soil, help greatly to compensate for organic matter losses with clean tilled crops. Crop residues, **alone** however, are not enough to maintain the organic matter supply of cultivated fields. When growing cash crops, it is desirable to keep the organic matter losses as low as possible, hence the return of crop residues is a sound practice to this end.

In utilizing crop residues, it should be noted that materials such as mature straw and cornstalks decompose slowly in the soil, because they contain only relatively small amounts of nitrogen. To decompose readily, plant material should contain approximately 1.5 per cent of nitrogen, otherwise the soil microbes

More farmers are adopting the practice of applying nitrogen fertilizer with crop residues before they are incorporated into the soil. Ammonium nitrate being spread on corn stover.

cannot obtain sufficient amounts of nitrogen for their own needs. Under such conditions, they use up the nitrogen in both the residues and in the soil. Unless extra nitrogen is supplied, the growing crop may suffer a temporary or even prolonged nitrogen starvation with consequent reduced yield. For this reason, many farmers are adopting the practice of applying nitrogen fertilizer on the straw or cornstalks, just before they are incorporated into the soil. This increases the rate of humus formation from the residues and makes possible the ultimate maintenance of a higher organic matter content in the soil.

FARMYARD MANURE HIGHLY RATED.

No other source of organic matter through the years has received a higher rating than has animal manure. Where crops are fed to livestock on the farm, about three quarters of the nutrients removed from the soil can be returned to the land in the form of manure. Thus livestock manure has a two-fold value in supplying both **nutrients** and **organic matter**! The relatively high proportion of nitrogen to organic matter in the manure is also a factor in its effectiveness in maintaining the supply in the soil. Livestock manure, if available, should be conserved against wastage and leaching losses, and should be applied to the land in moderate amounts for best return for each ton of manure used. Fresh, strawy, manure should be incorporated into the soil well in advance of the crop, to avoid the risk of temporary nitrogen starvation, (see crop residues above). Well rotted manure may be used, either for plowing under or as a top-dressing just before planting time, or on hay or pasture land to be broken up for a cultivated row crop.

Manure is still one of the most effective sources of organic matter.

ORGANIC MATTER CROPS.

In a cash cropping area, where livestock manure is scarce and crop residues are the main source of return of organic matter to the soil, there is a place for the resting of some of the land by growing a so-called "green manure" or cover crop, as an organic matter crop.

Two types of crops are commonly used for this purpose: legumes, (red clover sweet clover, alfalfa, alsike, soybeans, or vetch), and non-legumes, (rye, buckwheat, or millet). As pointed out in the discussion of balanced crop rotation, the legumes when inoculated have a superior effect through the nitrogen which they add when turned into the soil. Non-legumes, when used as organic matter or manure crops, do not add nitrogen to the soil; they only return what they have taken up from the soil.

The choice of crop for this purpose depends on local conditions and no hard and fast rule can be laid down. Plowing down **any one of the above crops** would be a treat for a soil hungry for organic matter. The secret of the effectiveness in the use of organic matter crops, is that the whole crops, tops, roots and all, must be incorporated into the soil. Organic matter crops can be made even more effective by liberal fertilization at time of planting. This increases both top and root growth, so that a larger total amount of dry matter is added to the soil. It also serves to introduce nitrogen, phosphate and potash into the soil through the organic medium, thus building-up reserves of fertility for succeeding crops. Thus fertilizers may be made to serve in a dual role when utilized in this way—to help to increase the supply of active organic matter and to supplement the soil's supply of native fertility.

Among the non-legume organic matter crops fertilized, fall rye gives good winter protection and a large volume of material to put into the soil early in the spring.

COMBINATION OF METHODS BEST.

Long experience has emphasized the fact that a combination of methods of maintaining organic matter in cultivated soils is likely to prove most effective. This is because no one method or source alone is likely to be adequate for all conditions. Soil type, drainage, aeration, intensity of cultivation, etc., all vary from place to place, and the problem is different on every farm. It is possible, however, to work out a system of soil management for each farm that will maintain both crop yields and soil organic matter.

This brings forth a principle that should be kept in mind in our thinking on the organic matter problem. Organic matter cannot be maintained in any soil without making provision also for the maintenance of soil fertility. This means that nitrogen and the mineral nutrients have to be provided for as well. Long term experiments in the United States have also shown that soil management practices that result in continued high yields of crops automatically maintain soil organic matter at an adequate level. Organic matter alone, however, seldom keeps crop yields at a high level.

What is needed in the final analysis is a **balanced system of soil management,** in which provision is made for the return of **both organic matter and fertility** in proportion to the annual losses from the soil. Anything less than this must lead inevitably to bankruptcy of the land.

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HINTS ON JUDGING LIVE STOCK AND BACON HOG CARCASSES

BY THE STAFF OF THE
DEPARTMENT OF ANIMAL HUSBANDRY
ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONTARIO

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ONTARIO DEPARTMENT of AGRICULTURE

STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

Bulletin 460 January, 1949

FOREWORD

This bulletin is presented primarily for the benefit of young men and women who are interested in live stock and live stock production. Should the information volunteered prove helpful to older folk, so much the better, since every man and woman, young or old, engaged in live stock production must be a competent judge if he or she hopes to succeed.

In presenting this publication, there is no thought of attempting to create the impression that judging is an end in itself. Observation will indicate that our outstanding live stock improvers have seen fit to use all of the tools at their command. Breeding ability, longevity of life, utility value, profitable production, acceptability to market demands, and many other factors have been used as additional yard stick measurements by the competent judge when selecting foundation breeding stock for his herd or other stock for specific purposes.

To be able to intelligently use these measurements, one must work with live stock, observe their strong points and their weak points, their habits, their response to management and feed, all the while keeping in mind the fact that the ultimate end of all breeding programs is the commercial animal.

The ability to judge in a competent manner, therefore, is in itself only one of the very important stepping stones in progressive live stock improvement.

The successful live stock farmer is a craftsman and, like the artist, he has an ideal. Successful live stock production in all of its aspects involves at one and the same time an appreciation and an application of the findings of science and the striving to attain an ideal.

Head of Department.

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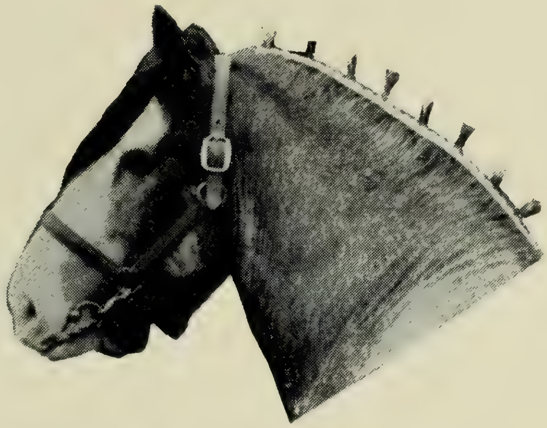
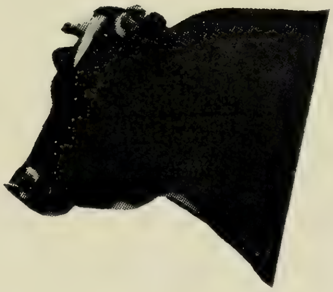
LEARN WHAT TO LOOK FOR IN A SIRE'S HEAD

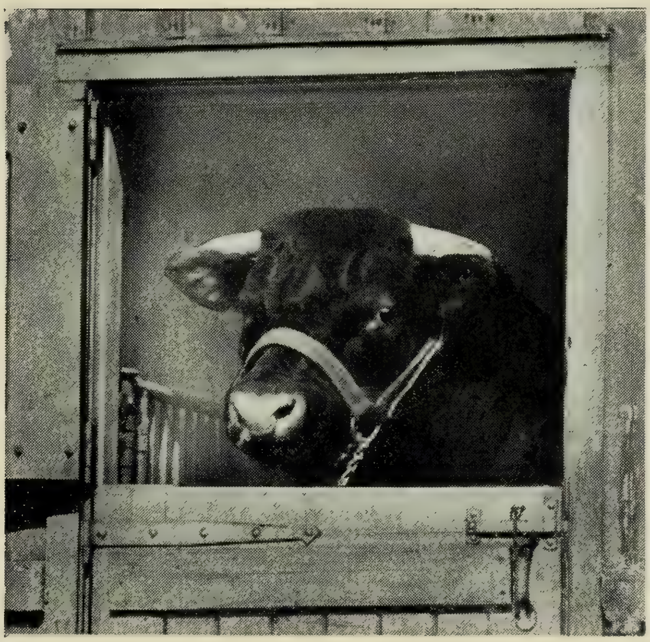
A sire's head is almost a never-failing criterion of his prepotency, that is, his inherent ability to transmit his characteristics to his get.





BREED CHARACTER

MASCULINITY



TEMPERAMENT

PREPOTENCY

TERMS USED IN DESCRIBING LIVE STOCK

There are a number of general terms commonly used in describing the characteristics of live stock. Such terms as type, breed type, breed character, constitution, balance, quality, substance, scale, finish, dairy temperament, when properly understood, make it unnecessary to engage in long, detailed discussions. If the application of these terms, however, is not properly understood, their use becomes confusing and usually meaningless.

(1) *Type* is an ideal or standard of perfection combining all of the characters which contribute to the animal's value and efficiency for the purpose specified. Type provides the animal with the proper form and structure for the kind of work or production required. In the development of our modern breeds, much consideration has been and is being given to breed type. This ideal is supposed to combine all of the characters which contribute to the animal's value and efficiency.

(2) *Breed Type* involves a number of characteristics which distinguish one breed from another. These are colour, shape, size, style, habits, etc. It is quite possible for an animal to possess most of the characteristics of his breed and yet not be a true representative of the breed to which he belongs. For example, he might have the correct colour, size, style and habits of his breed, and yet be so lacking in shape that he would not conform to breed type.

(3) *Breed Character* is often used in pointing out variations in the degree of development of such qualities as head appearance and conformation, colour, refinement, style, balance and carriage. There are, however, some characteristics common to some of our breeds that, while they are considered as breed characteristics, do not have any definite bearing on the utility value of an animal with respect to the extent to which it can efficiently turn the feeds which grow on our farms into an acceptable market product. For example, a modern Shropshire sheep should have rather small ears, well tucked into the head covering. The Suffolk, on the other hand, has large ears. Similarly, each of our Down breeds of sheep has its own distinct colouring of legs and face, and in the show ring much emphasis is placed on the correct shades of colouring. Furthermore, the modern standard in some of our breeds of sheep calls for wooling down to the nose; others are bare-faced or partly so. These are breed characteristics which must be taken into consideration when one is judging a ring of sheep of a given breed, in spite of the fact that they are not necessarily related to any utility value. By and large, however, type is more useful as a guide for the producers of commercial animals who are engaged in breeding live stock according to the demands of the markets of the day.

(4) *Balance* or *Symmetry* involves a harmonious development of all parts of the animal. In order to understand balance, one should know the names applied to the different parts of the animal and be able to recognize in detail the variations that are found in these parts as they may influence efficiency.

(5) *Quality* is generally understood as the opposite of coarseness. The term, "refinement" should not be substituted for quality. It is used in a relative sense because quality is not dependent upon the same degree of refinement in all breeds of live stock. An animal might be so refined that his small bones would impair his general usefulness. Quality is indicated by smooth, clean cut features throughout, which contribute to the beauty and general ability of the animal to economically perform the function for which he has been bred. Neat, clean cut, sound joints, a pliable hide, and a smooth finish are necessary attributes of quality.

(6) *Constitution* refers primarily to the chest capacity as it is determined by the length and fullness of the fore ribs and the width of the chest floor. A robust constitution is possible only when there is ample room for the heart and lungs to develop and function.

(7) *Spring of Rib* refers to the manner in which the ribs come out from the back bone. This conformation varies with different breeds of live stock. For example, in beef cattle and sheep we have the broad spring of rib. In dairy cattle, it is more or less angular, and in the case of the bacon hog, the desirable spring of rib is when it comes directly out from the back bone, and at a point in line with the shoulder and hip bone, turns abruptly down towards the ground, so that the side proper of the pig is approximately flat in appearance. In general, spring of rib is associated with strength of constitution.

(8) *Quality in Bone*. The term, "quality in bone" has reference to, as the name would imply, the strength and the size of it. When it is said that an animal has bone of quality, it is always inferred that the bone is flat, hard and flinty and not porous. This, of course, cannot be seen in the live animal. Quality in bone is usually indicated by the shape, quality and neatness of the joints (freedom from meatiness). Large, coarse bones and coarse joints are not associated with strength or good wearing qualities. It should be pointed out, however, that the strength of a joint such as the pastern joint or hock is controlled by the strength and the quality of the tendons which support the joint.

(9) *Scale* refers to development in size and frame. Flesh and fat, especially the latter, can deceive one as to the amount of scale which an animal may have.

(10) *Substance* is a term often times used in connection with beef cattle and is generally understood to apply to the amount of bone. General ruggedness throughout the body is usually associated with an adequate amount of bone.

(11) *Style* is a very inclusive term. It is usually associated with a harmonious development of all body characteristics. It is also a specific term in that it involves the general beauty of the animal and the degree of grace it displays while moving or at rest. Style is a very necessary attribute. Style is apparently the result of a controlled nervous temperament which enables the animal to appear graceful and attractive under varying conditions.

(12) *Finish* refers to a degree of fatness. A desirable finish involves not only an adequate amount of fatness, but the fatness must be smoothly distributed over the body. It must also be mellow yet firm and not soft or flabby.

(13) *Dairy Character*. The term "dairy character" is used to describe animation, angularity, general openness and freedom from excess tissue, giving due regard to the period of lactation in a dairy cow.

(14) *Beef Character* is a term which is oftentimes used in pointing out desirable variations in degree of development of such qualities as colour, refinement, style, beef producing form, balance and carriage as related to beef cattle. Such variations contribute to the distinctiveness of an animal in breed character and also in breed type.

(15) *Crimp* in wool refers to the waviness of a single strand of wool fibre. The finer the crimp, the finer the wool.

(16) *Density* refers to the thickness or number of wool fibres on a square inch of skin surface.

(17) *Lustre* in a fleece has reference to the brightness of the fleece. This brightness is determined by the character of the scale covering of the wool fibre.

(18) *Yolk* is the grease or oil which is secreted by the skin and which passes up through the cells forming the core of the wool fibre.

(19) *Kemp* is foreign fibre. It is not true wool, and like black fibre, will not take a dye when wool is being processed.

(20) *Score Card* is a description of the external of the model or perfect animal. At best, a score card can only serve as a guide. Score cards are published simply to help out the student to a proper understanding of the relative merits of the various points of the different classes of animals. It is not wise to attempt to depend upon a score card in actual judging practice.

PROCEDURE IN JUDGING LIVE STOCK

While suggestions will be offered as to the methods of procedure in judging the different classes of live stock under their respective headings, there are a number of essential steps in judging or placing a class which are as follows:

1. Knowledge of the ideal.
2. Observation and examination of the individuals.
3. Comparison of the individuals in the class.
4. Final decision as to the order in which the class should be placed.

In proceeding with the placing of a class of live stock, the first step to make is a general survey of the entire group of individuals by walking around and observing them from some distance. The general features such as type, breed character (in the case of breeding classes), style, form, scale, weight (in the case of market classes), quality and condition are then appraised in a general way.

This is followed by a more detailed study or inspection of each animal in the class at closer range from the side, rear and front.

In the case of horses, the class is moved to observe the action, when the horses are inspected at the walk and then the trot. It is well to observe the horse moving away from one and also towards one. In noting the action, the straightness, length, flexion, power, springiness and balance are to be considered. The judge should be on the watch for lameness which is a disqualification.

Next, by handling, condition is appraised, as well as other important features, for example, the mammary system of the dairy cow, the quality of her hide, etc. In the case of beef cattle, the amount and smoothness of the flesh are determined by touch or handling of the rib, back, loin, shoulder and covering on the spine. This is also true in the case of sheep. In addition, the character of the fleece on the sheep is determined by close inspection.

Finally, the contestant balances the points of one animal against another and arrives at his final decision as to the order in which the class should be placed. If the ideal animal is kept in mind and a careful comparison is made, it usually follows that the first decision is either correct or a close approach to it. It is seldom advisable for one to change one's mind unless an obvious mistake in judgment has been made.

PROCEDURE IN STATING REASONS BEFORE A JUDGE

A set of reasons is simply a concise explanation for one's decision as to how a ring of live stock should be placed. An excuse is not a reason. Sound judgment is based on the relative significance of the important characters common to a given animal. Therefore, when one is stating reasons for his judgment to a judge, it is quite essential that the contestant confine his thought primarily to those characters of the animals under consideration that have to do with utility value.

As for order of importance of *comparison,* it is a common and recommended practice that the contestant first names the class which he is discussing, and then states the order in which he places same. He next proceeds to *compare* his first and second prize winners, when he does so with respect to type and conformation. In the case of breeding classes, he *compares* them with respect to breed character and other breed type essentials such as dairy temperament in the case of dairy classes. Following this general *comparison,* in the limited time allowed him, he makes a *comparison* between his first and second prize winners with respect to other detailed characteristics such as constitution, depth of body, spring of rib, capacity, quality, amount and quality of finish (in the case of market animals), etc. The contestant continues to compare his second and third, and third and fourth, and so on, in like fashion.

A very common mistake made by beginners is that too much time is spent comparing the first and second prize winners, and not enough time is left to do justice to their judgment with the remaining animals in the class. Another common mistake is that of pointing out only the good or superior qualities of the first prize winner and not admitting that the same animal has some undesirable characteristics. In other words, the contestant does not convey to the judge that he, the contestant, properly saw his first prize animal, since he has not described it in completion. A competent contestant should be able to adequately and completely describe all of the animals with respect to all of their good and bad points in a minimum length of time, placing emphasis on the more important ones.

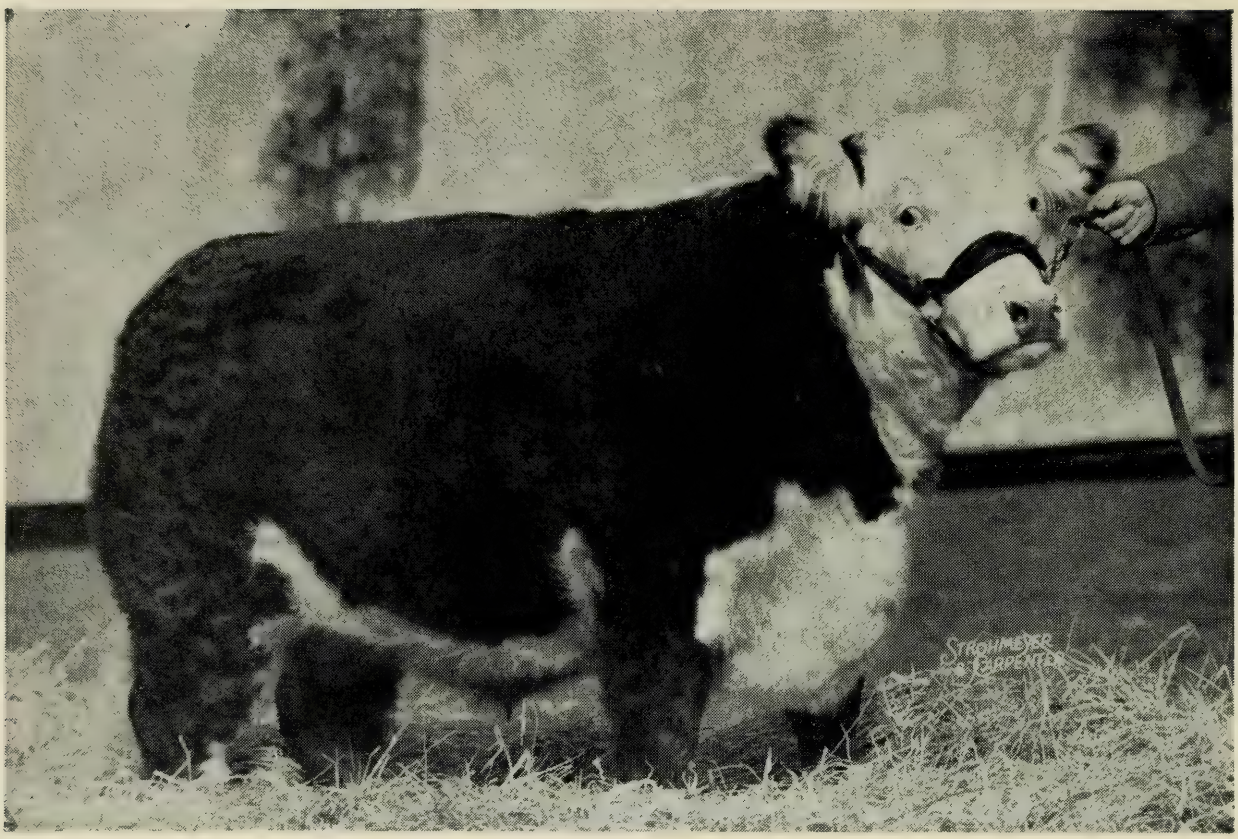
It is a general practice that animals in a judging contest are numbered from the left in the rear, 1, 2, 3, 4, or 5 as the case may be. At some judging contests, they are numbered A, B, C, D (and E if there is a fifth one in the class), likewise from the left in the rear. By using this system, all that is necessary for the contestant to say is, "I place the ring of (naming the class) in the following order: 1, 2, 3, 4", or whatever it may be. There is nothing to be gained by saying, "I place number 1 over number 2", because the judge knows the numbers just as well as you do, or at least he should do.

A memorized set of reasons is of little value. There is no set of reasons that will fit two classes of live stock. For the beginner, writing reasons will be of assistance insomuch that opportunity is afforded to see for oneself whether or not one's judgment is sound and whether or not the proper sequence is followed. The ability to volunteer reasons in an impressive manner for placing a ring of live stock is based on knowledge of the ideal animal, keenness of observation, retention of memory and power of description. All of these attributes are developed through experience and practice.

BEEF CATTLE

Beef Type

As previously described, type with reference to live stock denotes a kind of form, shape, conformation, or general appearance which is related to utility. In general, there is a relationship between form and performance. To the extent that this relationship exists, form can be used as a measure of value. In slaughter animals, there is a fairly high correlation between form and carcass value. The value of a beef carcass, for example, is dependent upon its quality, conformation and finish, which can be determined from the appearance of the animal on foot with a fair degree of accuracy. It is quite obvious that a thick, meaty beef carcass could not be secured from a slaughter animal that is lean and angular. The ideal of beef type implies not only high utility value of the carcass, but also high acceptability of the steer from the producer's stand-



The grand champion steer at the 1946 Royal Agricultural Winter Fair. The ultimate end of all breeding programs in beef cattle is the market steer. Note the blocky, thick, low set, sappy conformation of this model steer and how smoothly it is turned.

point. The ideal beef steer, then, is one that has made rapid and economical gains, as well as being of high grade or market value for a slaughter animal. The qualities which indicate rapidity and economy of gain, other than weight for age, are not so easily described.

The judging, selecting, or evaluating of beef steers is on the basis of the individuality of the steers. The desirable individuality is composed of the demands of consumers of beef and the requirements of cattle producers, or a sum total of those characteristics required in the make-up of an ideal animal. A steer making the maximum gain on the minimum of feed is desired by the producers, while the consumer wants good quality beef at a reasonable cost.

Suggested Score Card for a Market Steer

The finished beef steer is taken as the ideal as it is in greater demand than bulls, cows, or heifers, on the finished cattle market, and consequently sells for higher prices. The score card for breeding animals is fashioned after the beef steer standard of perfection, as the model breeding beef bull or cow is one capable of producing a calf which, when finished, will be an ideal steer. The essentials of type are the same for steers, cows, heifers and bulls.

Following is a score card suitable for a well bred market steer in prime condition, that has been properly fed from the time that it is born until it is marketed:

FINISHED MARKET STEER

Scale of Points:

GENERAL APPEARANCE—49 points

1. *Weight*—Score according to age. Estimate weight.
   4 months— 350 to 375 pounds
   8 months— 650 to 700 pounds
   12 months— 850 to 900 pounds
   18 months—1200 to 1250 pounds
2. *Form*—Straight top-line and under-line, deep, broad, low set, compact, symmetrical, stylish, not paunchy.
3. *Quality*—Hair soft and mossy, hide pliable, bone of medium development and strong, head clean-cut, body fleshing smooth and even, neither rolly nor patchy.
4. *Condition*—Degree of fatness as indicated by covering on the back, rib cover, fullness of purse and flank, proper texture, and finish as indicated by a mellow, yet firm and springy touch.
5. *Dressing Percentage*—High condition, a trim middle, thin hide, a general indication of quality.

HEAD AND NECK—5 points

6. *Muzzle*—Broad; *nostrils*—Large.
7. *Eyes*—Large, clear, quiet expression.
8. *Face*—Short, clean-cut.
9. *Forehead*—Broad.
10. *Ears*—Medium size, fine texture.
11. *Horns*—When left on for show purposes, fine texture, medium size, well shaped.
12. *Neck*—Short, thick, clean-cut at the throat.

FOREQUARTERS—9 points

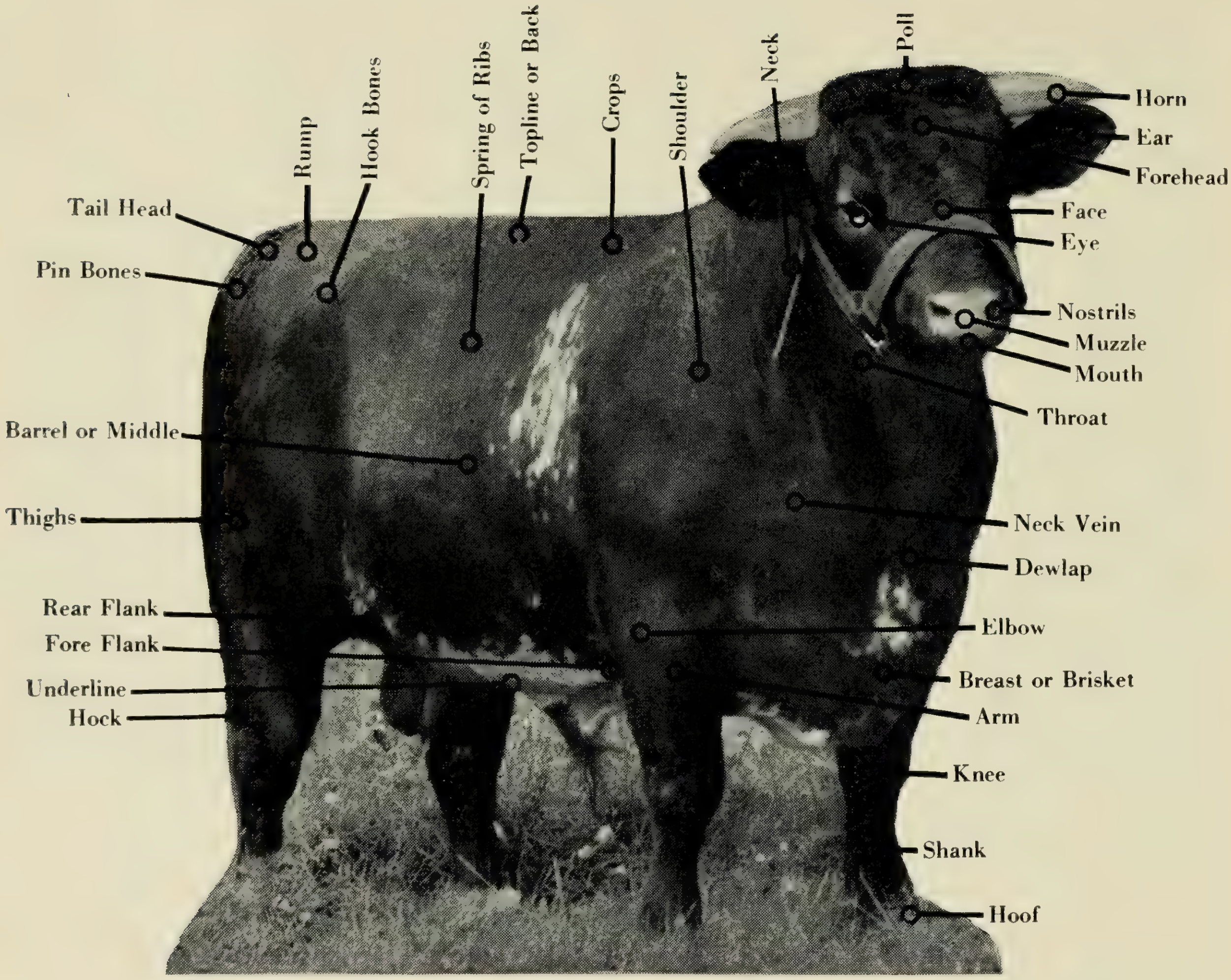
13. *Shoulder* or *Neck Vein*—Well filled.
14. *Shoulder*—Well covered with flesh, wide and smooth on top.
15. *Brisket*—Not overly developed, neat and trim.
16. *Legs* and *Feet*—Straight, wide apart, short, the arm full, the shank medium fine, feet well shaped.

BODY—23 points

17. *Chest*—Deep, wide, crops full.
18. *Ribs*—Long, well arched, broad across the top, covered with thick, firm, smooth flesh.
19. *Loin*—Broad, covered with thick, smooth flesh.
20. *Flank*—Full, even with underline.

HINDQUARTERS—14 points

21. *Hooks*—Well laid in and smoothly covered.
22. *Rump*—Long, wide, level, smooth at tail head.
23. *Thighs*—Plump, deep, wide from front to rear and thick.
24. *Twist*—Deep, well filled.
25. *Legs* and *Feet*—Straight, short, shank medium fine, feet well shaped.



POINTS OF A BEEF ANIMAL

SCORE CARD PARTS

The following is a description of the parts of the score card:

GENERAL APPEARANCE

The general appearance may be divided into weight, form, quality, finish and dressing percentage.

(1) *Weight*—The capacity for weight increase is determined by heredity, while feeding and management determine the extent to which that capacity is fulfilled. Heredity, then, sets the pattern and the management on the part of the owner governs the extent of completion.

Of all of the items considered in appraising a market steer, weight for age is the most important from the producer's standpoint because rapid gains are usually economical gains. As cattle are sold by weight, the buyer is not concerned with weight as it is related to age unless it influences the grade of the carcass. Slow-gaining, late-maturing beef cattle usually lack in quality of carcass. To the meat packer, the weight of a slaughter animal on foot is an important factor because it places the carcass in a weight class which yields retail cuts of certain weights and quality. Though some heavy carcasses are in demand, the demand has been consistently shifting towards finished cattle of lighter weights. Sex, like age, is linked with weight, as the males are heavier at all ages. Breed differences in weight are also to be found.

(2) *Conformation*—When finished, the beef steer is broad, deep, compact and low set. A poor steer in form is narrow, shallow, rangy and leggy. A top grade beef carcass in form is yielded only by steers that are wide, deep, short-coupled and short-legged. Straightness of the top-line, under-line and side-lines is highly desirable. The top-line is perhaps of importance only as it is related to appearance. Side-lines and bottom-lines are of greater economic importance because they have to do with trimness of middle and balance of parts. A good beef steer must be balanced, that is, all parts must be uniformly well developed.

(3) *Quality*—The grader of beef carcasses attaches more emphasis to the item of quality than to any other single point. It is necessary, then, in the beef steer, to give attention to those features of quality which reveal themselves or are shown in the carcass. Smoothness of form and fleshing are highly desirable. A soft, mossy coat of hair and a pliable, not heavy hide are indicators of quality. The refinement of the head, the quality of the horns and bone also denote quality. Refinement in this regard can be carried too far because sufficient strength and ruggedness are prerequisites to to profitable performance in the feed lot.

A steer with a clean-cut head, not too heavy bone, fine hair coat, pliable hide, that is free from roughness in fleshing and smooth throughout is one with quality. From such steers, high quality carcasses are yielded. The coarse, rough steer will not produce a high quality, attractive carcass which will have appeal to the customer in the butcher store.

(4) *Finish or Condition and Fleshing*—Top selling beef carcasses must carry a sufficient amount of fat. Consequently, the market steer must have a sufficient amount of finish. Lack of finish is a common fault in market steers. Yet overfinish is not uncommon in heavy, older cattle. Finish beyond that desired by the consumer is uneconomical because it is costly to produce and much fat must be trimmed off by the retail store-keeper before he offers it for sale.

The finish of a steer may be appraised fairly accurately at some distance. However, close differences can be ascertained only by handling. The back and rib covering and that on the point of the shoulder indicate the fatness as well as do also the fullness of the flank and the purse. The handling of the fleshing should be mellow yet firm and springy. The covering of flesh may be too soft or too hard, as well as insufficient. Fleshing that is a mixture of fat and lean is the most important character of beef in the opinion of the consumer. It is this inter-mixing (marbling), combined with a covering of fat, that makes beef tender and highly palatable. Lean meat or muscle covering is commonly referred to as "natural fleshing" by the cattle raiser.

(5) *Dressing Percentage*—Cattle that are highly finished, trim middled, light in the hide, shanks and head, will yield a relatively high percentage of carcass when slaughtered. A high carcass yield adds to market value. Although light-middled, fine-boned steers may dress high, it is quite obvious that these qualities can be carried too far when one keeps in mind economical production. We want evidences of a high dressing percentage, but not at the expense of general ruggedness and profitable production with respect to the capacity to consume feed under normal conditions.

HEAD AND NECK

Of all the main divisions of the score card, the head and neck are allotted the fewest number of points and are probably of minor consequence in the meat value of a slaughter beef animal.

(6) *Head*—A medium-sized head is suggested under quality. In shape, a rather short, wide head with a broad muzzle is desired. By the appearance of the head, the tem-

perament and disposition may be estimated. A quiet disposition is associated with a good feeding steer.

(7) *Neck*—A short, thick, muscular neck, clean-cut at the throat is required in a good steer. A short neck is associated with the general requirement in form. A long-legged, rangy steer usually has a long, thin neck.

FOREQUARTERS

The forequarters on the live steer on the score card are not comparable with the forequarters on the beef carcass mainly because a section between the fore and hind quarters is designated as "body". The forequarter is a section of lesser value than the other portions except the head and neck.

(8) *Neck Vein*—The junction between the neck and shoulder is blended together at the neck vein. This part is full and plump in a good steer so that no marked division can be noted.

(9) *Shoulder*—As the shoulder is a source of the wholesale cut of wide demand, it should be well covered with flesh, wide and smooth on top. A smooth blending of this part with the others is desired. Heavy, rough, open shoulders are not desired.

(10) *Brisket*—A minimum of brisket is wanted in a slaughter steer because this is one of the lowest priced cuts.

(11) *Legs*—Legs are of little consequence when the steer is finished, provided that they are strong enough to carry him across the scale. However, the profitableness of a steer in the feed lot is to quite an extent dependent upon the quality and strength of his legs, and style is influenced by the legs. Straight, strong, short legs, set wide apart, are desirable and a well developed muscular arm is preferred.

BODY

The body embraces some of the important high priced cuts and is, as a consequence, the division which receives nearly one-quarter of the points on the score card. In general, great width should typify the ideal steer, but shortness is desired in body length. Compact or short-bodied market cattle yield carcasses which have the desired form.

(12) *Chest*—The chest is that portion between the shoulders and immediately behind them and includes that part called the crops. Great width and depth, with well filled crops, are highly desirable. In fact, a steer cannot be too wide or deep in the chest. The girth of a steer just back of the fore leg is the heart girth. A large heart girth indicates constitutional vigour.

(13) *Ribs*—As commonly described, the ribs include the back. In the carcass, this portion is the wholesale cut of beef known as the ribs. A straight, wide back (broad spring of rib), in the live animal is desired. (In the carcass, the rib cut is restricted to the top part of the ribs from the shoulders to the beginning of the loin at the last rib.) As this portion yields one of the higher priced beef cuts, it should be heavily, smoothly and firmly fleshed. The thickness or depth of the flesh is determined by the touch with the palm and fingers.

(14) *Loin*—The loin extends along the top-line from the ribs back to the hip or hook bone. When broad, heavily fleshed and smooth, it complies with the requirements. Of the wholesale cuts of beef, the loin is in the greatest demand and sells for the highest price per pound. Along the top-line, especially on the rear part of the back or the forward part of the loin, there may be adhesions of the hide to the back bone and a depression in the fleshing develops as the animal is fattened. Such a depression is called a tie and is not desirable.

(15) *Flank* — A flank that is full and even with the underline is desired in the finished steer.

HINDQUARTERS

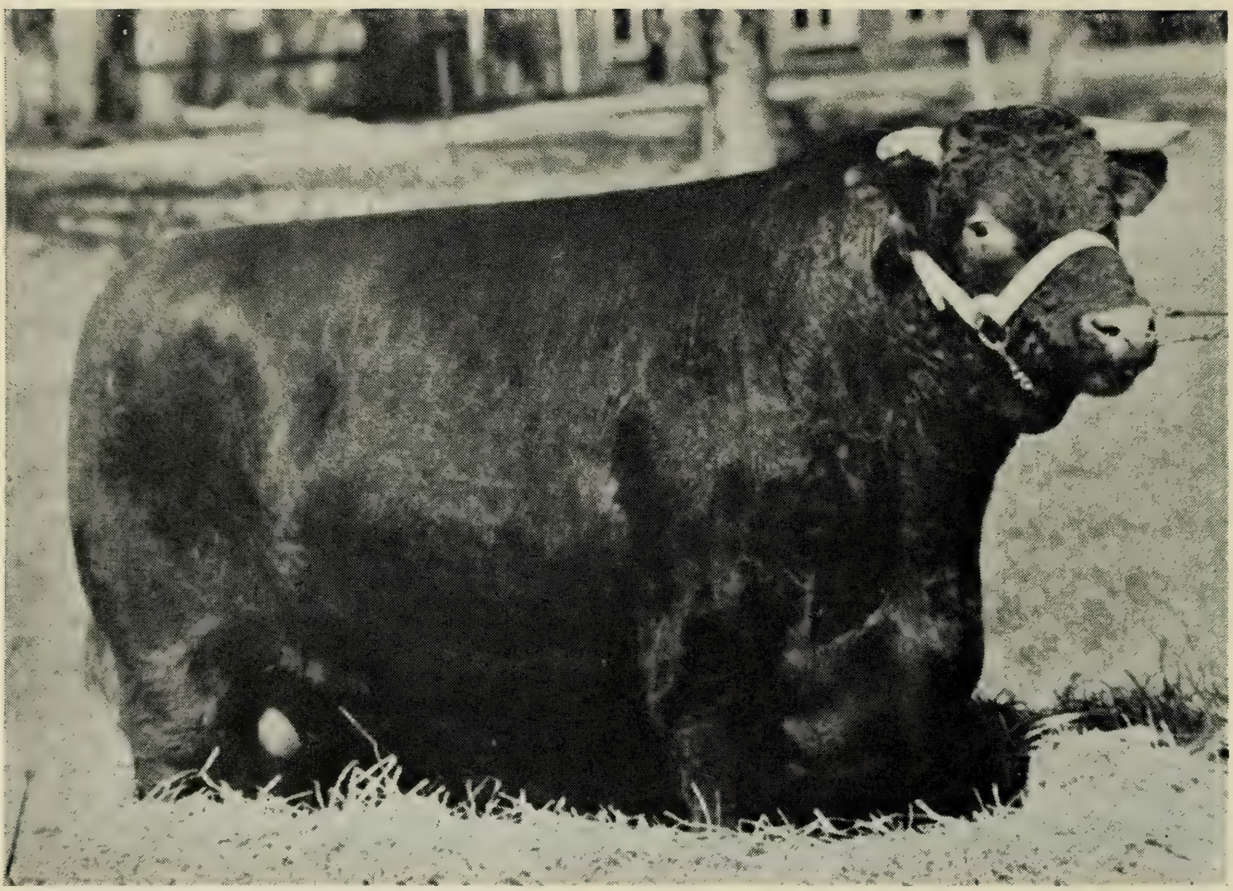
(16) *Hooks*—The prominence of the hips is known as the hooks in cattle. A finished steer should not have visible prominence of the hooks. A well set in, smoothly covered hook bone is desirable.

(17) *Rump*—The part of the steer along the top from the hook bone to the tail head is known as the rump. A part of this is included in the wholesale beef cut, the loin, and the remainder is known as the rump cut. A long, wide, level rump, which is smoothly fleshed is desired. Patchiness at the tail head is undesirable. Patchiness is wastiness.

(18) *Thighs*—The outer part of the round that is below the rump is called the thigh. It should be plump, deep, and wide from front to rear of leg. Too often, beef cattle are light in the hind quarters or not uniform in width. When narrow behind or high in the thighs, a light round in the carcass results. The plumper and better filled the round, the shorter the shank, the larger the proportion of round that can be sold as round steak.

(19) *Twist*—The inner thigh is called the twist and the fullness of the twist helps to determine the size of the beef round in the carcass. It should be deep, full and plump. A steer that is cut up between the thighs is undesirable.

(20) *Legs*—The hind legs, as the fore legs, should be ample to carry the weight of the finished steer. As in the front legs, sufficient bone is needed to carry the steer, but on the other hand, not too large or coarse.



A proven Shorthorn herd sire. Note the low setness, short, broad head, masculinity, substance, smoothness and general quality of this bull. He could be criticized for having a somewhat round and coarse horn.

BEEF BREEDS

Shorthorns

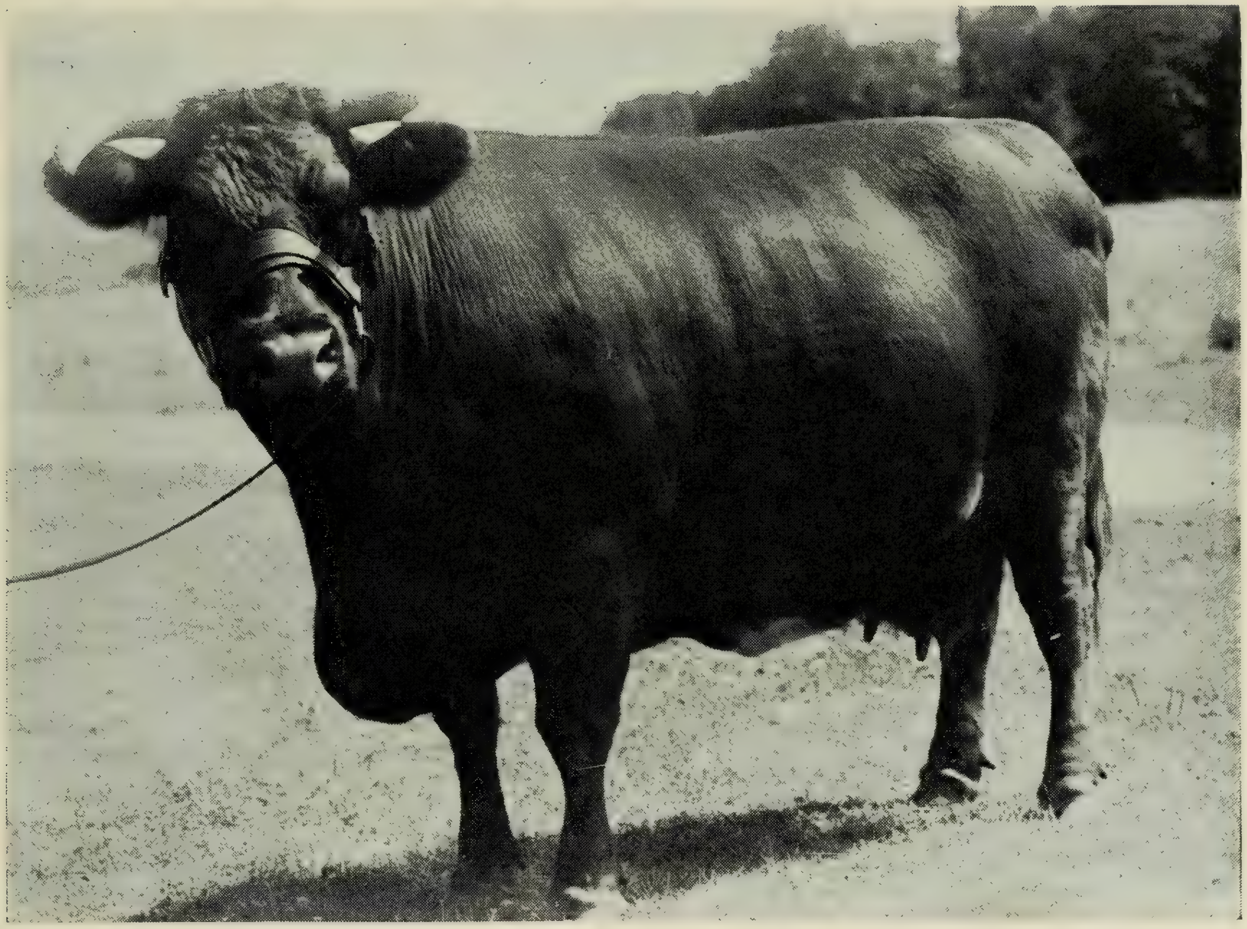
Shorthorn colours are red, white and roan. Roans and reds are most popular, Broken colours, that is, a mixture of red and white, are not desirable. A white switch. a star or white underline on a red body, however, are not objectionable. Black muzzles are highly objectionable.

The modern Shorthorn conforms to the ideal beef type. He is deep, thick, short-coupled, smooth, short-legged and carries a wealth of natural fleshing under a mossy coat of hair. He has a short, broad head, a prominent yet placid eye, with a medium fine, flat, white, waxy coloured horn, preferably coming out straight from the poll, then turning inward and slightly forward.

Shorthorn cattle at maturity will outweigh other beef breeds as found in Canada. Mature bulls will weigh from 1800 to 2300, and cows from 1300 to 1700 pounds. There are two strains of beef type Shorthorns, horned and polled. The horned strain is the more popular in Canada, although there appears to be an increasing interest in the polled strain.

There is a third strain of Shorthorns that has been developed for the production of milk as well as beef. These cattle are known as Milking Shorthorns in the United States, Dairy Shorthorns in England and Australia, and Dual Purpose Shorthorns in Canada.

Although it has been the aim of breeders of this type of cattle to develop strains the cows of which would be capable of producing large quantities of milk, and the steer calves from them capable of producing carcasses acceptable to the beef trade, the tendency has been to give the milking qualities more emphasis than those associated with beef. Notwithstanding this fact, there are families of Dual Purpose Shorthorns



A typical Shorthorn cow in desirable breeding condition. Again, note the substance of this cow, together with the strong, broad muzzle, broad face, prominent eye, alertness, and yet feminine expression. Attention is also called to the indication that this cow should be capable of raising her own calf.

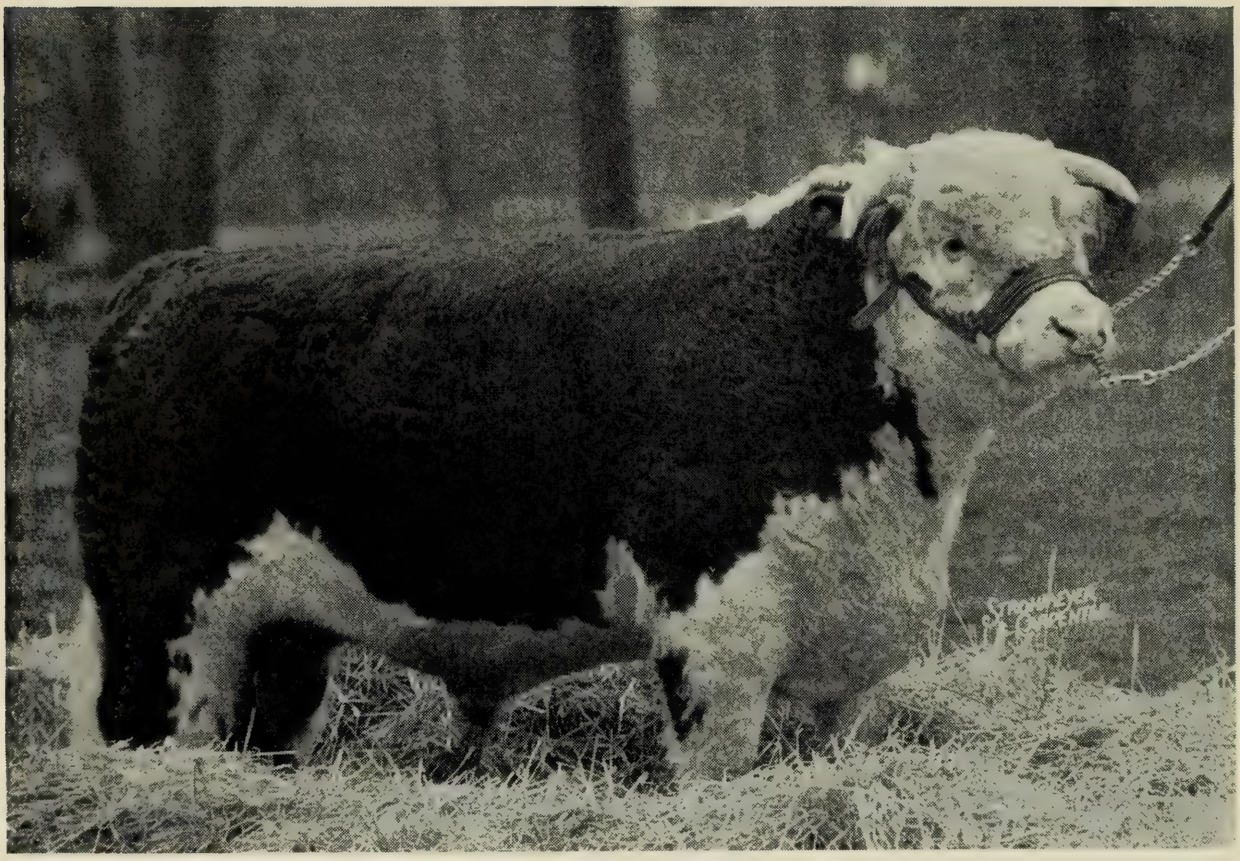
in Canada that are quite capable of producing a considerable volume of milk, and at the same time continue to inherit and transmit their beef making tendencies.

As such, they can be described as cattle having somewhat of a more finely cut head, and at the same time it can be described as broad, the eyes prominent and lively, and the muzzle wide and quite expansive.

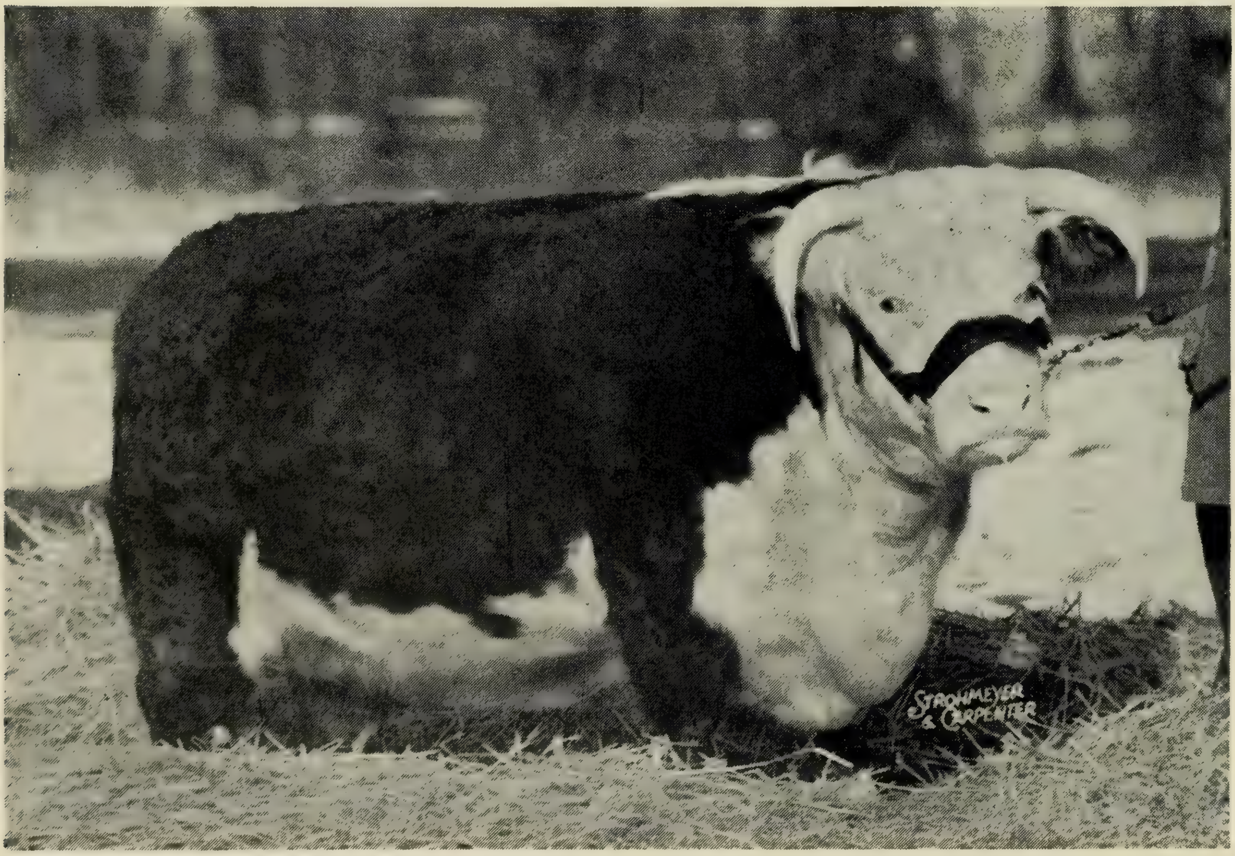
Bulls of the Dual Purpose type are not as broad across the withers as beef type sires, but they should have the same broad and deep chest, deep in their middles, broad over their loins, and the hind quarters are long, broad and level. Like the Scotch Shorthorn, they must show evidence of quality in skin and fleshing.

Opposite to the bulls of this particular strain, the head of the Dual Purpose female takes on a considerable dairy type expression. She is very clean-cut about the throat and head and lean of her neck. With the exception of her shoulder conformation which is somewhat angular, her body conformation, as is the case with her fleshing, hide and hair, resembles to a considerable extent that of the other strains of Shorthorns. The hind quarters of a Dual Purpose Shorthorn female should be level and long from hook to pin bones, and when viewed from the rear, they should be wide and the legs straight. Her udder is well attached, thin skinned, with pronounced milk veins, large in capacity, not fleshy or split up between quarters. It extends high up the back, hanging almost perpendicularly, and running well forward in line with the belly. The teats are of good even size, squarely placed and well apart. The milk veins about the abdomen are highly developed.

As for colour, reds and roans are preferred, but breeders of Dual Purpose Shorthorns do not take the same exception to broken colours as do the breeders of Scotch Shorthorns.



A very good example of a Hereford sire. Note the bold, strong, masculine head, the strong muzzle, the short neck, the straight, even top line, the well developed hind quarters, and the general appearance of ruggedness.



A model Hereford heifer. Observe the strength of the face and width of the muzzle, and yet the head is feminine in appearance. Attention is called to the blockiness, the lowsetness, the indication of quality, the smoothness, and the mossy coat of hair.

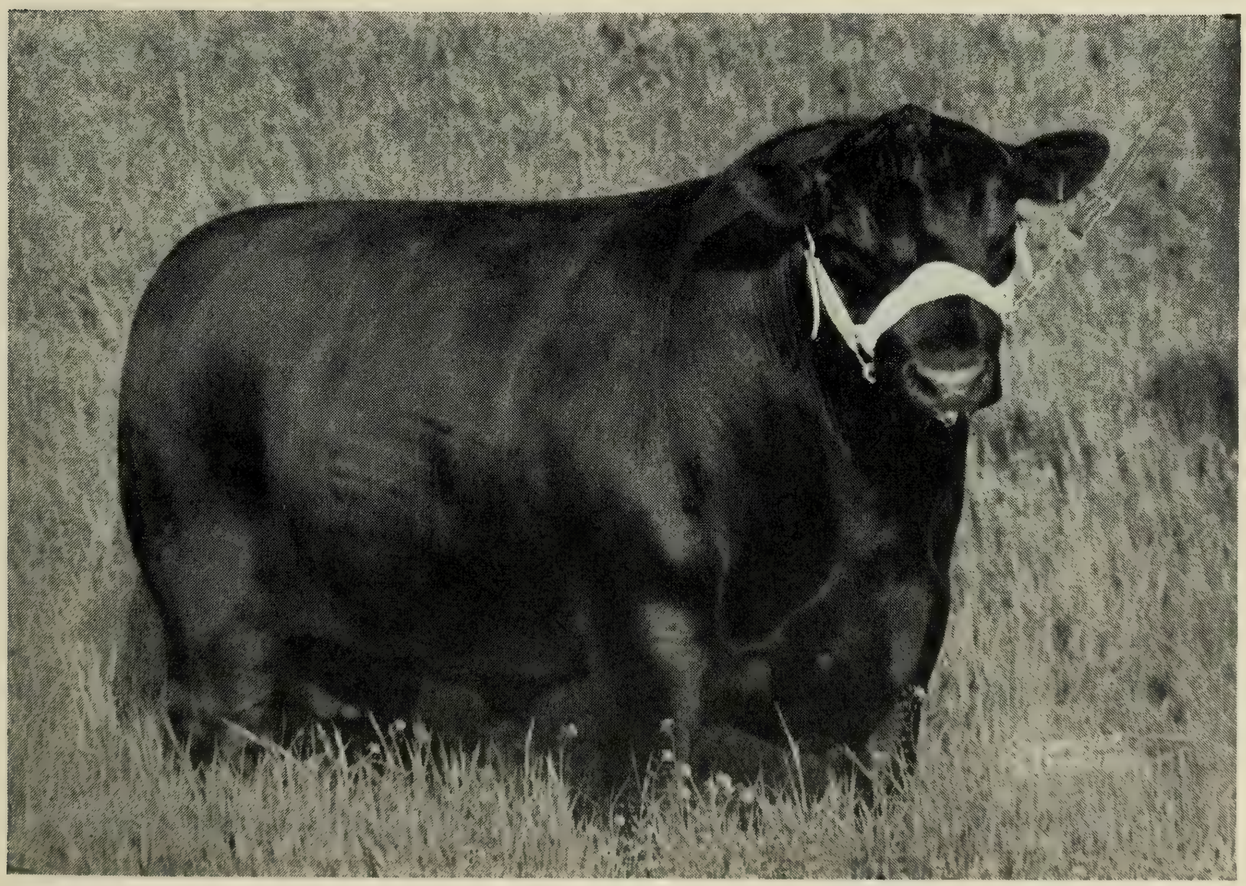
Herefords

Herefords are red and white in colour. The colour pattern is quite attractive and varies only a little. The body is predominantly red, and the face white, with the white colour extending over the top of the neck and withers, throat, breast, belly, ankles and switch. The red colour may vary from light to dark, but a medium deep rich red is favoured. Breeders object to the occurrence of white back of the crops, high on the flanks, or too high on the legs. They are smoothly fleshed and possibly a little thicker in the hide than the other beef breeds, and have quite a lot of bone as compared with the Aberdeen Angus in particular. The muzzle should be a clear white, and the horn should be white or yellow and waxy.

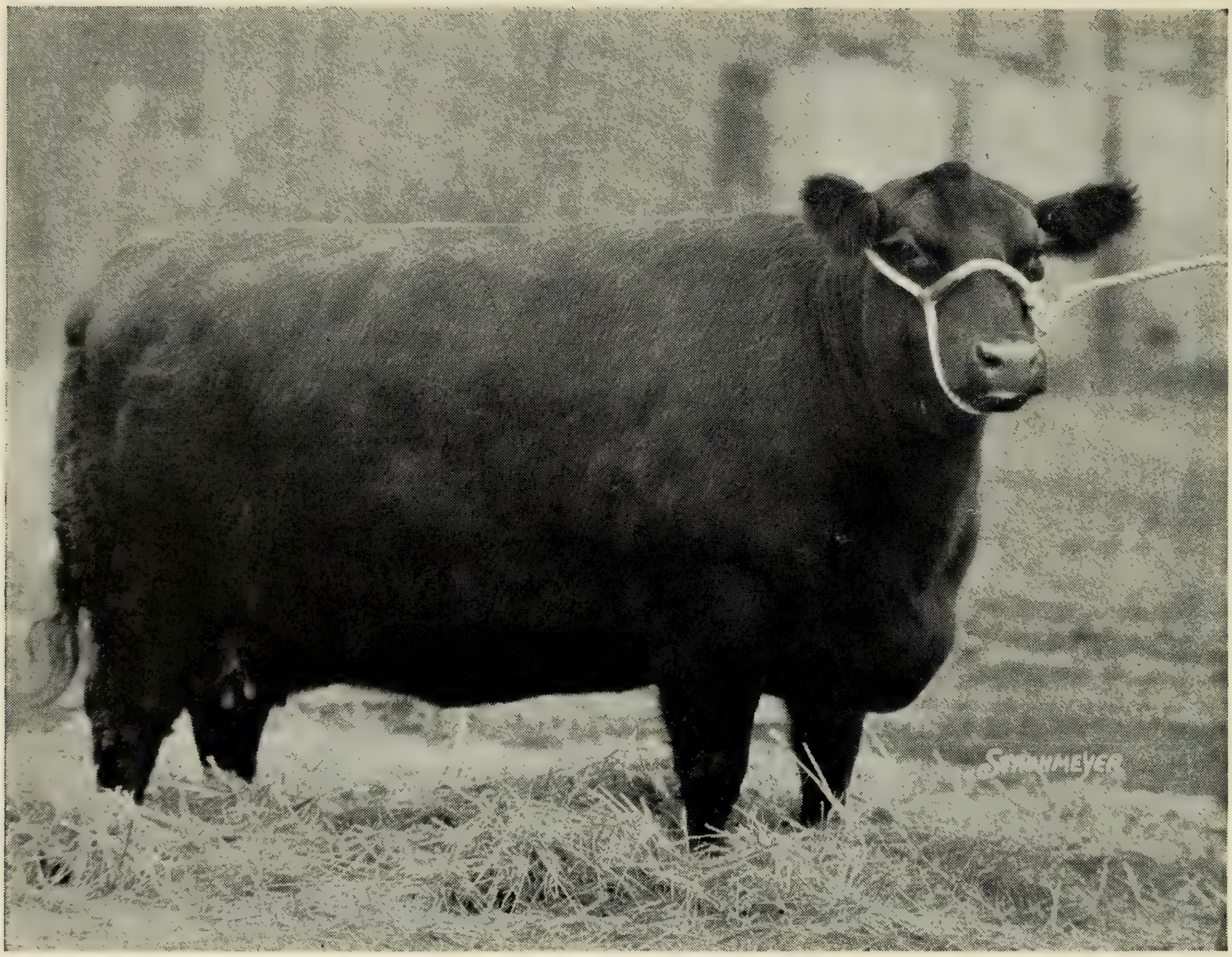
Herefords conform strictly to beef type. Bulls of the breed may be expected to weigh from 1700 to 2200 pounds at maturity, and cows from 1200 to 1600 pounds. In a general way, the Hereford must be considered as one of the heavy breeds. There are two strains of Hereford cattle, one horned and one polled. The horned strain is the more commonly found in Canada.

Aberdeen Angus

The principal distinguishing features about the Aberdeen Angus breed are the black colour, the polled or hornless character, symmetrical bodies and smooth fleshing. The head should be short and broad, with a broad muzzle and a well defined poll. A flat poll is objectionable. An Aberdeen Angus that is not black in colour or with any solid patch of white above the underline or on leg or legs, or with scurs, is not eligible for registration.



A very good model of an Aberdeen Angus herd sire. Note the short, broad head, with the prominent poll, the crested neck and the roundness and smoothness of form, together with indications of quality throughout.



A desirable type of Aberdeen Angus breeding female. Note her feminine head, depth of body, her thickness and smoothness of fleshing.

The good individuals of the breed are straight in top and under-line, smooth in form, deep, thick, low set and mellow fleshed. The general shape, however, is somewhat more rounded than is the case with the Shorthorn or Hereford (this is most noticeable over the loin). In general, the Aberdeen Angus conforms in all details to beef type. The breed is outstanding in point of fleshing qualities. The bone of the Aberdeen Angus is comparatively small, but strong. In size, bulls at maturity will weigh from 1700 to 2000 pounds, and cows from 1200 to 1600 pounds.

JUDGING BREEDING BEEF CATTLE

As is the case in the selection of any sire, a bull's head is almost an unfailing criterion of his ability to transmit his characteristics to his get. The strong, well-formed head is invariably associated with equally desirable quality and form. The bull possessed of a well-formed, masculine head invariably has a lot of merit back of it. After one has determined to one's satisfaction the desirable breed characteristics that may be found in the general conformation of a breeding animal, one looks to the head for assurance as to whether or not these desirable characteristics will be transmitted to the offspring. In the case of a bull, this is probably more important than it is in the case of the females, because of the fact that he will be mated with many females, not necessarily all of the same character, type and conformation. On the other hand, every producing female has equal opportunity with the sire to influence her offspring. Therefore, too much emphasis cannot be placed on one's appraisal of breeding females. Breeding females should not only possess approved type and quality, but also that all important factor known as breed character.

The sire's head should be impressive. Masculinity, strength, balance, prominence of eye, width of muzzle and strength of jaw, with a short, broad face, broad across the poll and a docile expression are all very important.

Standing back, one should look for a uniformly sturdy body, great depth, burliness, short, wide, masculine head, strong crested neck, and in general a bold, masculine appearance with heavy muscling. He should stand on short, straight, sturdy legs.

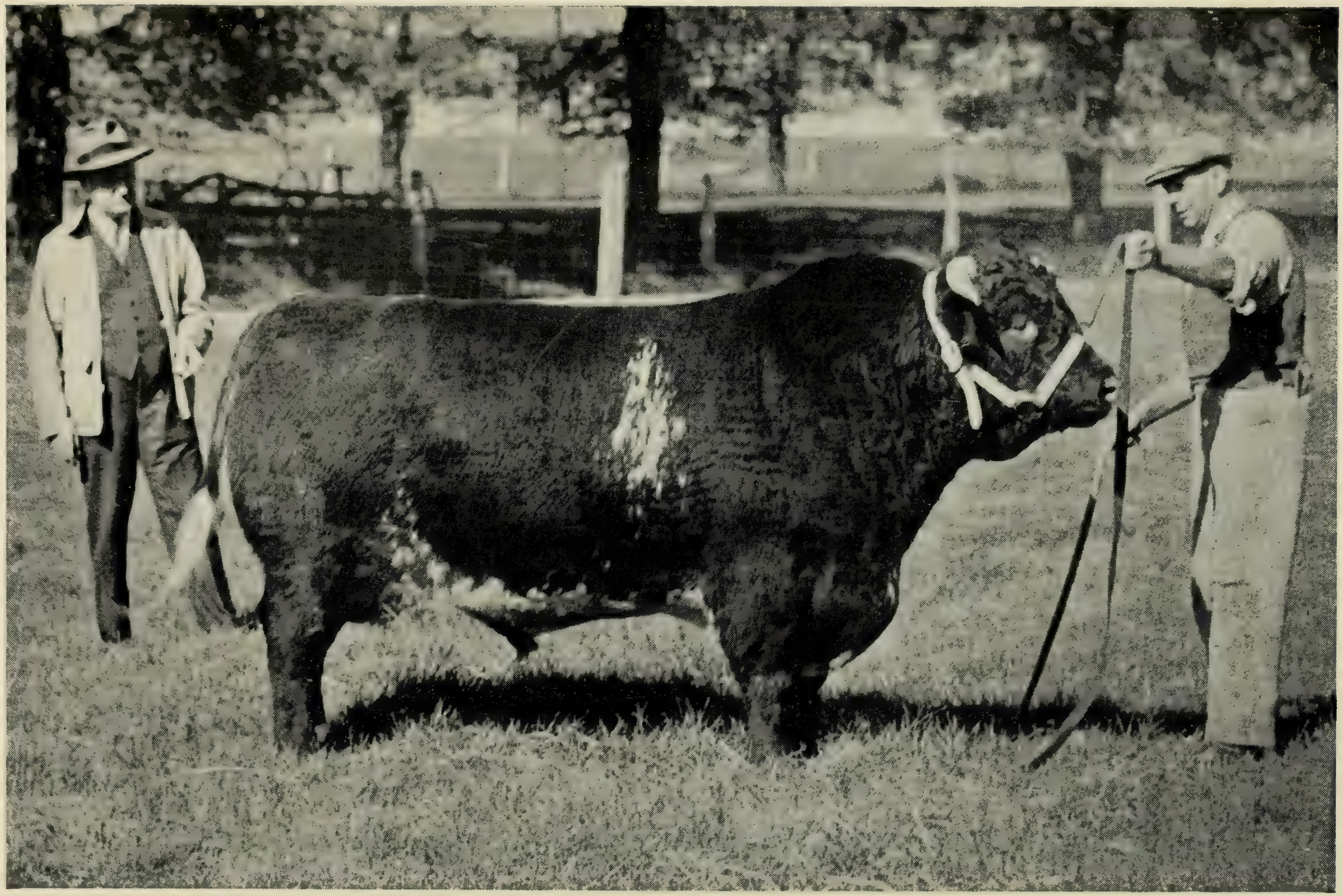
As opposed to the male, the female should show greater refinement throughout. The head, neck and shoulders should be free from the heavy appearance as seen in the bull and should show fineness and quality. The skin should be thinner and mellower, and the hair finer and silkier. The hips should be wider than what one looks for in the sire, and she should have a deep, roomy middle, with a mammary system development that would indicate that she will give enough milk to raise her own calf.

JUDGING A BEEF TYPE HERD SIRE

The following suggestions are offered with respect to a method of procedure in judging a beef type herd sire. For purpose of illustration, a Shorthorn sire has been used, and it should be pointed out that, in the main, the cardinal characteristics of all beef type sires are the same so far as body conformation is concerned. It is true that the breed characteristics do differ between breeds and the student will find it necessary to make himself familiar with the breed characteristics as may be common to the different breeds.

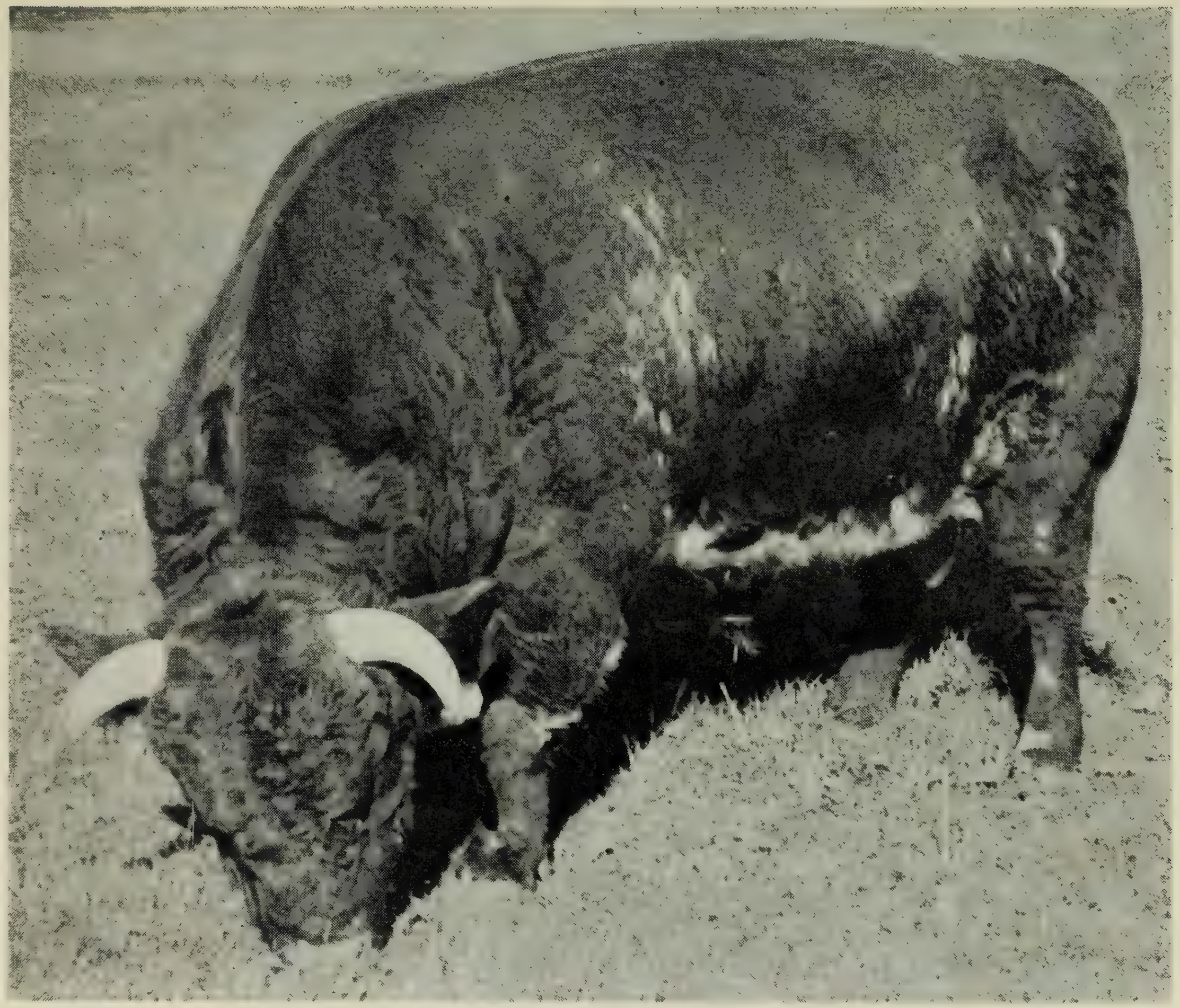
When judging other classes of beef cattle, the same procedure can be very well followed. As opposed to masculinity, and the characters associated with masculinity, femininity in all of its aspects should be considered when one is judging female breeding stock.

In the case of market cattle, still greater emphasis should be placed on the amount or depth of fleshing, as well as quality and probable dressing percentage.



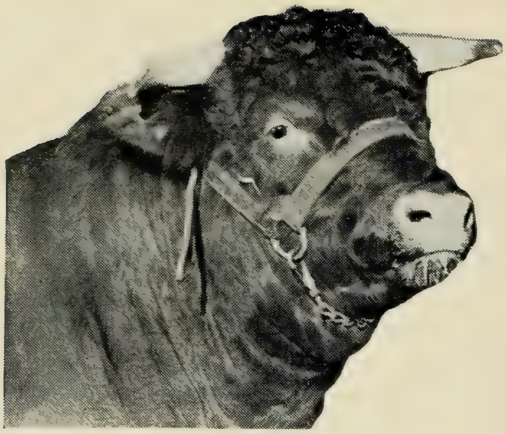
STEP No. 1

The first step in judging a herd sire is to get an over-all picture and appraise the bull as to type, size for age, general symmetry and balance, amount of bone, shortness of leg, and how he walks.



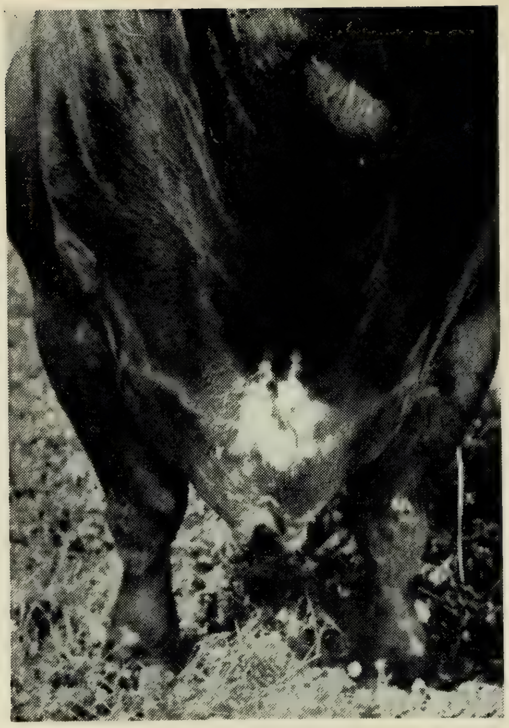
STEP No. 2

It is often advantageous to inspect a herd sire when he is in his natural pose, since one is more likely to see the faults in conformation. He should show a uniformly sturdy body, great depth, with straight top and under lines, burliness, a short, wide, masculine head, a strong, crested neck, and he should stand on short, straight, sturdy legs, correctly placed under him.



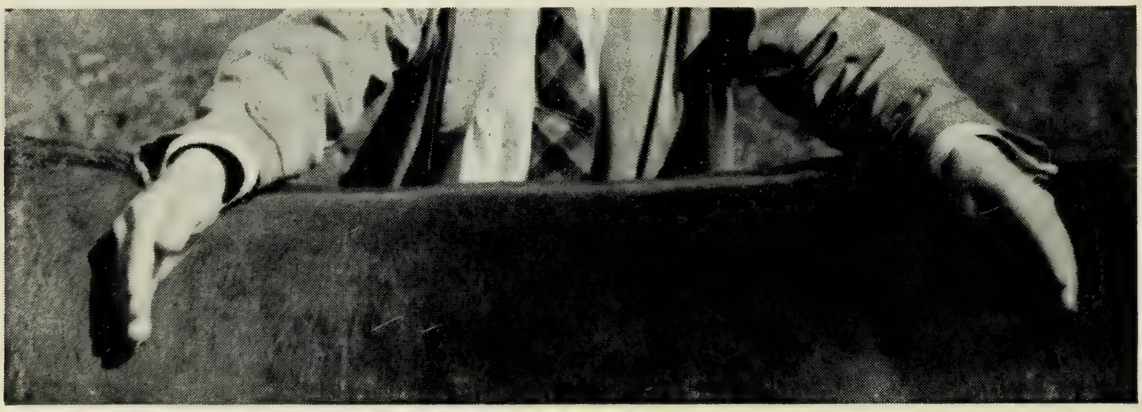
STEP No. 3

The head should be strong, wide across the poll, wide between the eyes, short from the eye to the nostril. Wide, open nostrils and a broad, strong muzzle are highly desirable. (In the case of Herefords and Shorthorns, the nose should be light in colour. Aberdeen Angus noses are black). He should have a kindly expression about his face which is slightly dished. The neck is short and thick, the throat is clean-cut and the crest well developed. In the case of a horned breed, the horn should be turned slightly down with a flat base. In the case of polled breeds, the poll should be prominent and free of scurs.



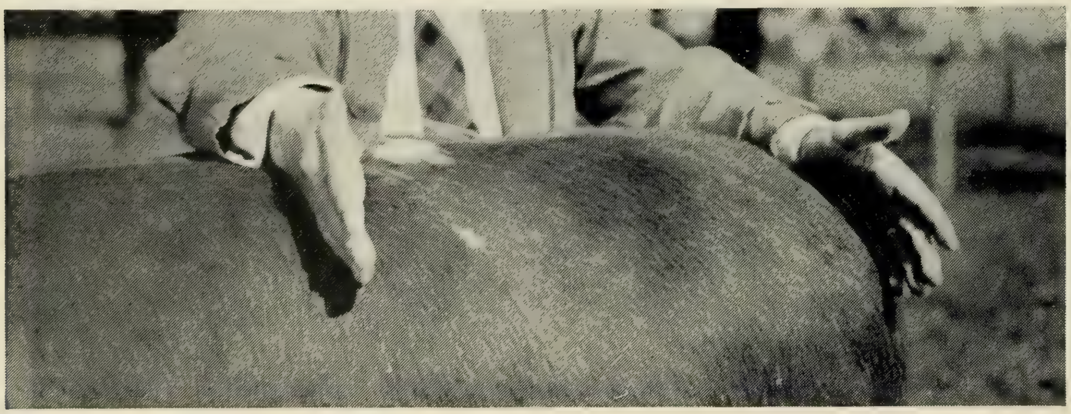
STEP No. 4

Study closely the width in front which is related with the width of the chest floor. A wide chest floor means strong constitution, plenty of vigour, and all round ruggedness.



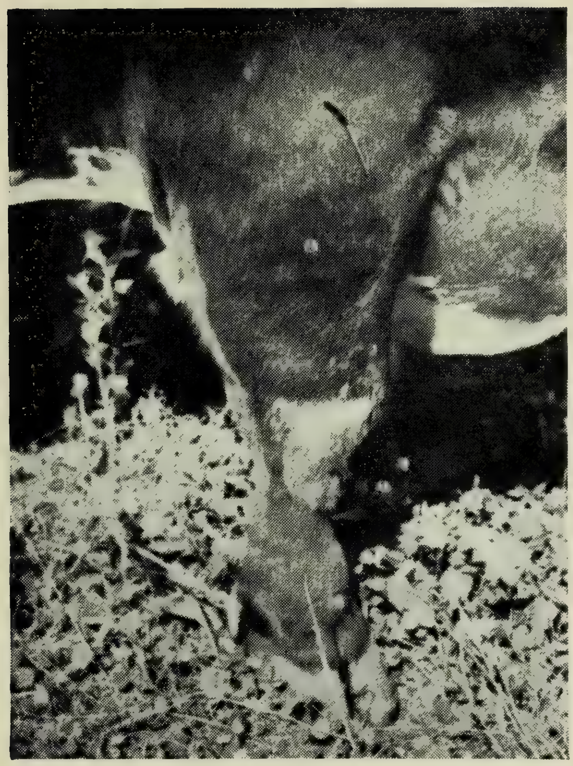
STEP No. 5

A strong, short back, commonly called closely coupled, is desirable. Closely coupled cattle usually mature early. Early maturity is a requisite of present-day market demands.



STEP No. 6

Length from hook bones to pin bones should be long, level and also deeply fleshed (no patchiness).



STEP No. 7

The fore arm should be short and heavily muscled. Muscling of the fore arm is often used as an index to natural fleshing throughout the body.

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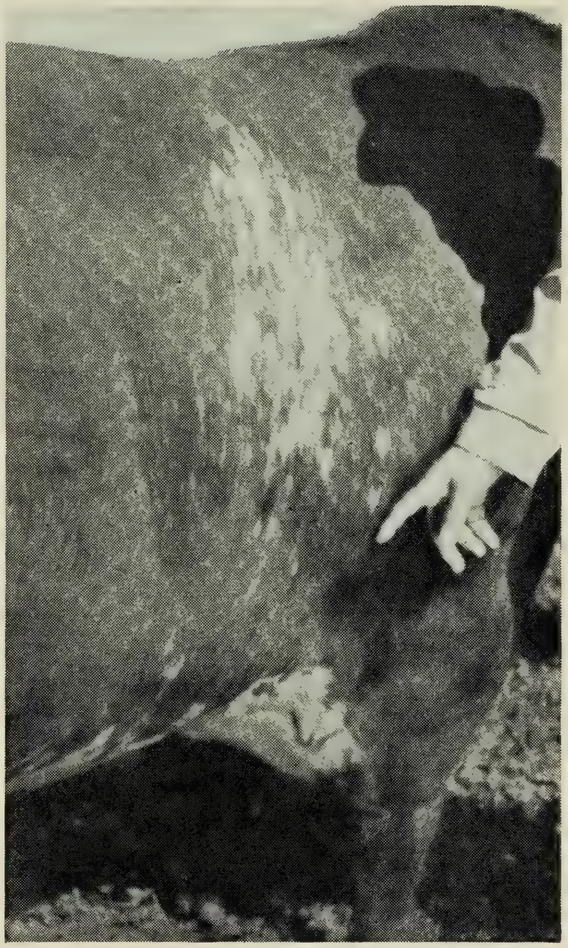
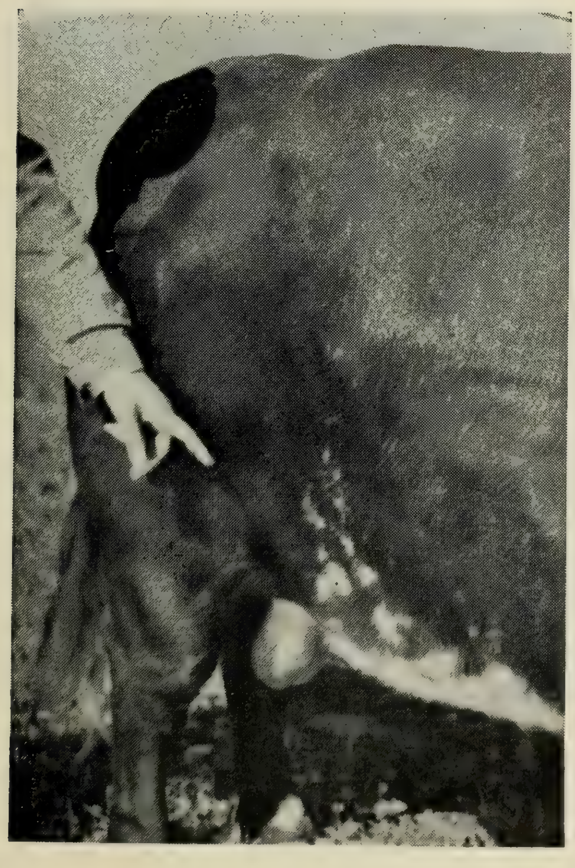


STEP No. 8

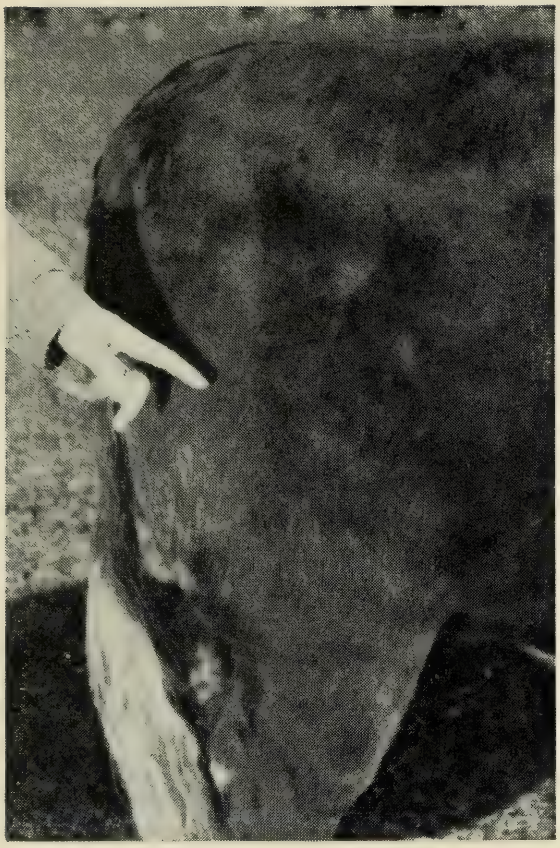
There should be a great depth of rib, fullness back of the shoulders and fullness in the fore flank. All of these features are indicative of a great constitution. This particular part of the body is usually spoken of as heart girth. The shoulder should blend smoothly into the body.

●



STEP No. 9

The rear flank, too, should be well let down. A full fore flank and rear flank make for a straight under line. Attention is called to the character and quality of bone which is necessary. A bull should stand on strong, flinty bone, with clean-cut, strong hocks, and he should stand squarely on his legs.



STEP No. 10

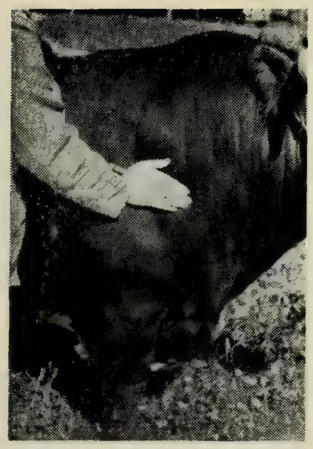
The thigh, when viewed from the side, should be thick, full and deep, and carried down toward the hock.

STEP No. 11

Note the depth of the rear end. The round carries well down to the hock. Observe how well he is filled in the twist.

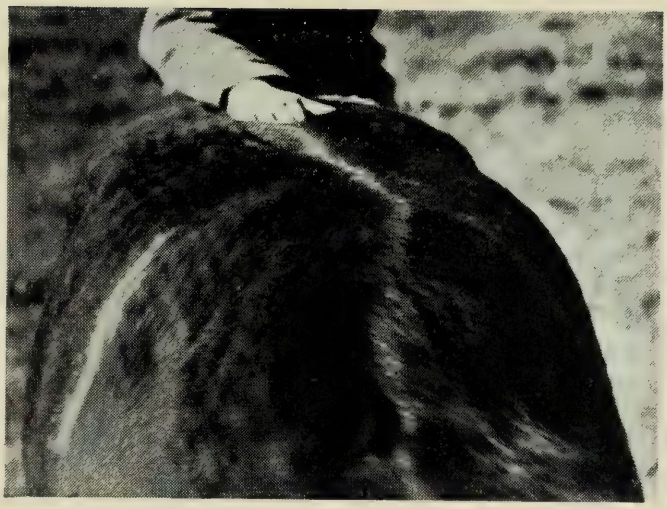
STEP No. 12

He should be well filled between the hook and pin bones, and his tail head should be smooth.



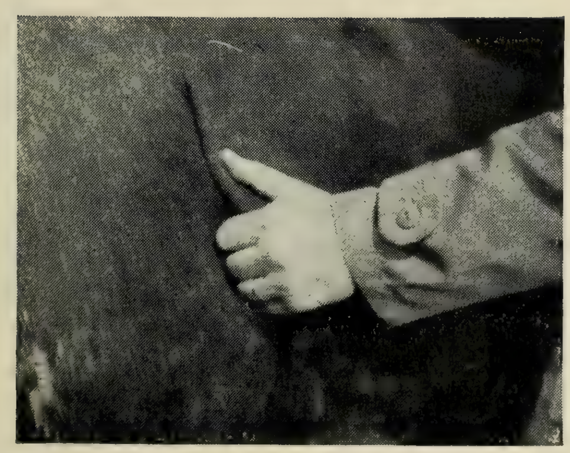
STEP No. 13

The next step is to make a close examination of the fleshing. The neck vein should be well filled. There should be a smooth junction of the neck into the shoulder.



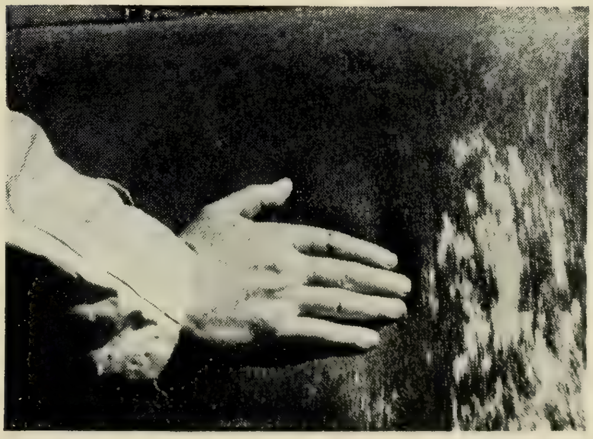
STEP No. 14

Thick, natural fleshing, evenly distributed over the entire body of the animal, is of primary importance. Looking over his back, he should have a great spring of rib and should have the same width from his shoulders to his hook bones. This means that the width of the shoulder, the width of the spring of rib, and the width of the loin are all approximately the same, and that his hook bones are smoothly set into his body. This same width should carry out from the loin to the pin bones.



STEP No. 15

A loose, pliable hide is associated with thick fleshing and the ability to make rapid gains.



STEP No. 16

As is the case with his back, he should be evenly fleshed over his ribs. Fleshing should not be hard to the touch, but rather mellow, with a certain amount of springiness to it. Quality of fleshing is most essential.

DAIRY CATTLE

Judging dairy cattle, like the judging of all classes of stock, is largely a matter of keen observation, balanced appraisal of good points and defects and the constant study of type to ensure close relationship between body form and efficient production. Expertness in judging is the result of a long period of training and considerable experience. Judging contests, coaching by trained, experienced men, and type conferences all have a place in developing and training judges, but it must be remembered that all this effort is supplementary. Judging live stock is an individual effort and the observations, analyses and final decisions must be made by the individual, be he a live stock breeder, farmer helper, student, dealer or leading judge at a major show.

Who should judge? Every man and woman (young or old) who has any responsibility for the raising, developing, showing or merchandizing of dairy cattle is a judge of the animals. The cane-carrying experts who place the awards in the show rings represent a relatively small percentage of the people who are, or should be, interested in judging. The purpose of this section is to present some ideas or hints on the approved type or conformation of dairy cattle. It is primarily prepared for the young and not the fully experienced, and will be developed, as the title of this bulletin suggests, as "Hints on Judging".

Hint No. 1

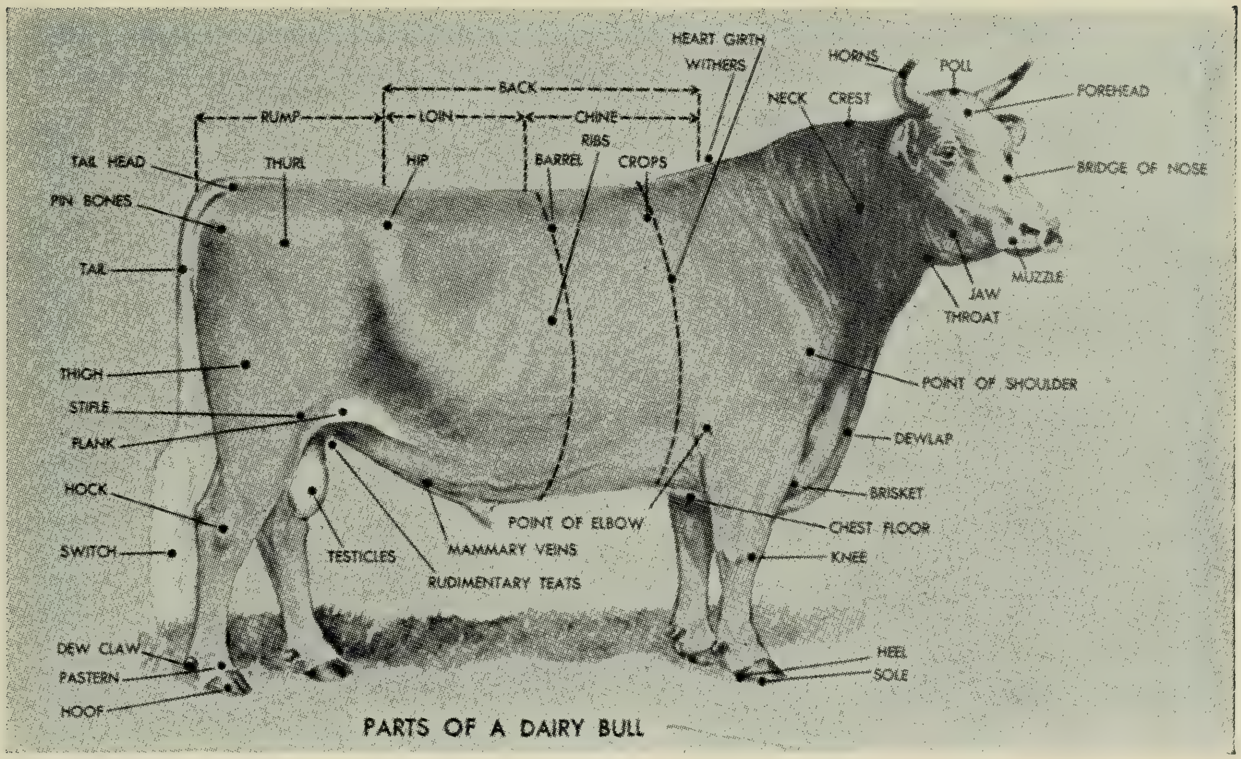
Know the names and the location of the parts of an animal. Obviously it is not possible to intelligently discuss type unless the exact location of the parts is known and the proper name used. Even in expert circles some confusion exists in terminology. To become familiar with the terms, a careful study of the diagrams of the dairy bull and dairy cow is strongly recommended.

Hint No. 2

Know the Score Card. The score card or, as it is sometimes called, the scale of points, has been used for a long period of time to describe and evaluate the parts of the ideal animal. Some of the early developed cards were very confusing and difficult to use. Separate score cards were used for each of the breeds of dairy cattle, further adding to the confusion. Omitting the breed characteristics, the basic conformation of all of the breeds of dairy cattle is fundamentally the same. Realizing this, a committee representing the breeders of all of the breeds of dairy cattle was named to study the problem of score cards. In 1943, on the recommendation of this committee, a uniform score card for all the dairy breeds was approved. While the present card has not been adopted as the official score card for the detailed scoring of some breeds, it is in general use and particularly useful for a general appraisal of an animal.

The score card for cows is divided into four main sections: General Appearance, including the breed characteristics, 30 points; Dairy Character, 20 points; Body Capacity, 20 points; Mammary System, 30 points. The sections are sub-divided, giving a score for each sub-section. The animal can be scored by using the figure assigned to the four main sections, or by using the sub-section points for a more detailed appraisal.

The score card for the bull is somewhat different from the score card for the cow. The points are rearranged and the terminology is slightly different. Study carefully the score card for the male and the female to become familiar with Hint No. 2.



PARTS OF A DAIRY BULL

DAIRY BULL SCORE CARD

Ideals of type and breed characteristics must be considered in the application of the terminology of this score card.

Based on Order of Observation:

GENERAL APPEARANCE—30 points

Attractive individuality, revealing vigour, masculinity with a harmonious blending and correlation of parts. Impressive style and attractive carriage with an active, well balanced walk.

Breed Characteristics

1. *Head*—Masculine, medium in length, clean-cut; broad muzzle with large open nostrils; lean, strong jaw; full, bright eyes; forehead broad between the eyes and moderately dished; bridge of nose straight; ears medium size and alertly carried.
2. *Shoulder Blades*—Set smoothly against chest wall and withers, forming neat junction with the body.
3. *Back*—Strong and appearing straight with vertebrae well defined.
4. *Loin*—Broad, strong and nearly level.
5. *Rump*—Long, wide; top-line level from loin to and including tail head.
   - (a) *Hips*—Wide, approximately level laterally with back, free from excess tissue.
   - (b) *Thurls*—Wide apart.
   - (c) *Pin Bones*—Wide apart and slightly lower than hips, well defined.
   - (d) *Tail Head*—Slightly above and neatly set between pin bones.
   - (e) *Tail*—Long and tapering with nicely balanced switch.

DAIRY CHARACTER—35 points

Animation, angularity, general openness, and freedom from excess tissue.

6. *Neck*—Masculine and long, with moderate crest blending smoothly into shoulders. Clean-cut throat, brisket and dewlap.
7. *Withers*—Well defined and wedge-shaped with the dorsal processes of the vertebrae rising slightly above the shoulder blades.
8. *Ribs*—Well arched, wide apart, rib bone flat, wide and long.
9. *Flanks*—Arched and refined.
10. *Thighs*—When viewed from the side, flat; when viewed from the rear, wide apart. Well cut-up between the thighs.
11. *Skin*—Of medium thickness, loose and pliable. Hair fine.
12. *Testicles*—Both normal. Scrotum normal.
13. *Rudimentary Teats*—Wide apart, squarely placed and in front of scrotum.
14. *Mammary Veins*—Large, long and well defined.

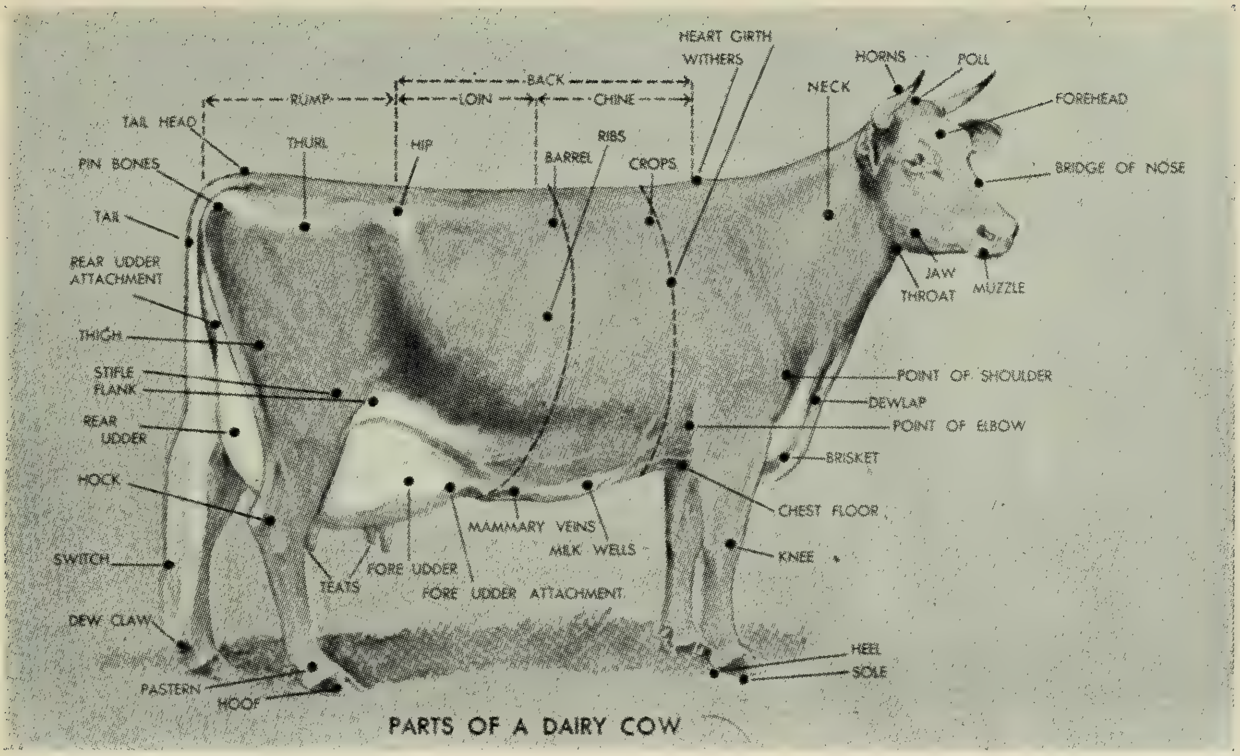
BODY CAPACITY—20 points

Relatively large in proportion to size of animal, and deep at the flank, providing ample digestive capacity, strength and vigour.

15. *Barrel*—Deep, strongly supported, ribs wide apart, and well sprung.
16. *Heart Girth*—Large, resulting from long, well sprung foreribs, wide chest floor between front legs, and fullness at the point of elbow.

LEGS AND FEET—15 points

17. *Fore Legs*—Medium in length, straight, wide apart, squarely placed. Feet short, and well rounded, with deep heel and level sole.
18. *Hind Legs*—When viewed from the side, nearly perpendicular from hock to pastern. When viewed from the rear, legs wide apart and nearly straight. Bone, flat and flinty, tendons well defined. Pasterns, of medium length, strong, and springy. Hocks cleanly moulded. Feet same as above.



PARTS OF A DAIRY COW

DAIRY COW SCORE CARD

Ideals of type and breed characteristics must be considered in the application of the terminology of this score card.

Based on Order of Observation:

GENERAL APPEARANCE—30 points

Attractive individuality, revealing vigour, femininity with a harmonious blending and correlation of parts. Impressive style and attractive carriage with a graceful walk.

Breed Characteristics

1. *Head*—Medium in length, clean-cut; broad muzzle with large open nostrils; lean, strong jaw; full, bright eyes; forehead broad between the eyes and moderately dished; bridge of nose straight; ears medium size and alertly carried.
2. *Shoulder Blades*—Set smoothly against chest wall and withers, forming neat junction with the body.
3. *Back*—Strong and appearing straight with vertebrae well defined.
4. *Loin*—Broad, strong and nearly level.
5. *Rump*—Long, wide; top-line level from loin to and including tail head.
    (a) *Hips*—Wide, approximately level laterally with back, free from excess tissue.
    (b) *Thurls*—Wide apart.
    (c) *Pin Bones*—Wide apart and slightly lower than hips, well defined.
    (d) *Tail Head*—Slightly above and neatly set between pin bones.
    (e) *Tail*—Long and tapering with nicely balanced switch.

6. *Legs*—Wide apart, squarely set, clean-cut and strong with fore legs straight.

   Hind Legs—Nearly perpendicular from hock to pastern. When viewed from behind, legs wide apart and nearly straight. Bone, flat and flinty, tendons well defined. Pasterns, of medium length, strong and springy. Hocks cleanly moulded.

7. *Feet*—Short and well rounded, with deep heel and level sole.

DAIRY CHARACTER—20 points

Animation, angularity, general openness, and freedom from excess tissue, giving due regard to period of lactation.

8. *Neck*—Long and lean, blending smoothly into shoulders and brisket; clean-cut throat and dewlap.

9. *Withers*—Well defined and wedge-shaped with the dorsal processes of the vertebrae rising slightly above the shoulder blades.

10. *Ribs*—Wide apart. Rib bone wide, flat and long.

11. *Flank*—Deep, arched and refined.

12. *Thighs*—Incurving to flat from the side; wide apart when viewed from the rear, providing sufficient room for the udder and its attachment.

13. *Skin*—Of medium thickness, loose, and pliable. Hair fine.

BODY CAPACITY—20 points

Relatively large in proportion to size of animal, providing ample digestive capacity, strength and vigour.

14. *Barrel*—Deep, strongly supported, ribs wide apart and well sprung; depth and width tending to increase toward rear of barrel.

15. *Heart Girth*—Large, resulting from long, well sprung foreribs, wide chest floor between front legs, and fullness at the point of elbow.

MAMMARY SYSTEM—30 points

A capacious, strongly attached, well carried udder of good quality, indicating heavy production and a long period of usefulness.

16. *Udder—capacity* and *shape*—Long, wide and of moderate depth. Extending well forward, strongly attached, reasonably level floor. Rear attachment, high and wide. Quarters evenly balanced and symmetrical.

    Texture—Soft, pliable and elastic. Well collapsed after milking.

    Teats—Uniform, of convenient length and size, cylindrical in shape, free from obstructions, well apart and squarely placed, plumb.

17. *Mammary Veins*—Long, tortuous, prominent and branching, with numerous large wells. Veins on udder numerous and clearly defined.

Hint No. 3

Learn to use the score card. In scoring an animal, the following procedure is suggested:

1. A thorough working knowledge of the score card.

2. An examination of the animal from a distance of 10 to 15 feet. It is often advisable to have the animal led around so that the walk, carriage and balance may be correctly ascertained.

3. Handle the animal to get the indications of the quality of the skin. The udder should be manipulated to evaluate the texture. Too much handling may lead to confusion. Learn to use the eye rather than the hand in scoring and judging animals.

The score card is used in teaching the elements of live stock judging. It tends to develop keen and critical observation and a balanced judgment. Judges working in the show ring do not use a score card. Through experience, they are able to quickly size up an animal, but it must be remembered that this ability has been developed through years of study and experience.

Having studied an animal and being familiar with the score card, the problem of getting the type facts on paper is presented. No single system for scoring has been approved or advised by any authorized group. One judge will use one method, while another will use an entirely different one, and in the final answer, both judges will have approximately the same score. The kind of method used does not matter so much, but there must be one; otherwise the judge will become hopelessly lost in the detail of scoring.

Considerable study has been undertaken with respect to an efficient yet simple method of scoring, and a one which involves the use of "cuts" seems to be the most satisfactory. With this method, a deduction is made from the perfect score allotted to each division. When the scoring is completed, the deductions are totalled, subtracted from the perfect total score, and the final figure is the score for the animal. This method allows the judge to use small numbers, reduces mathematical calculations to a minimum, and affords the judge an opportunity to indicate his observations on type in a properly appraised manner.

SCHEDULE OF CUTS FOR USE IN SCORING ANIMALS

Rating of Part in %	*60%*	*70%*	*72.5%*	*75%*	*77.5%*	*80%*	*82.5%*	*85.0%*	*87.5%*	*90.0%*	*92.5%*	*95%*	*97.5%*	*Rating of Part in %*
Points on Score Card	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Points on Score Card
1	.40	.30	.27	.25	.22	.20	.17	.15	.12	.10	.07	.05	.02	1
2	.80	.60	.55	.50	.45	.40	.35	.30	.25	.20	.15	.10	.05	2
3	1.20	.90	.82	.75	.67	.60	.52	.45	.37	.30	.22	.15	.07	3
4	1.60	1.20	1.00	1.00	.90	.80	.70	.60	.50	.40	.30	.20	.10	4
5	2.00	1.50	1.37	1.25	1.12	1.00	.87	.75	.62	.50	.37	.25	.12	5
6	2.40	1.80	1.65	1.50	1.35	1.20	1.05	.90	.75	.60	.45	.30	.15	6
7	2.80	2.10	1.92	1.75	1.57	1.40	1.22	1.05	.87	.70	.52	.35	.17	7
8	3.20	2.40	2.20	2.00	1.80	1.60	1.40	1.20	1.00	.80	.60	.40	.20	8
9	3.60	2.70	2.47	2.25	2.02	1.80	1.57	1.35	1.12	.90	.67	.45	.22	9
10	4.00	3.00	2.75	2.50	2.25	2.00	1.75	1.50	1.25	1.00	.75	.50	.25	10
12	4.80	3.60	3.30	3.00	2.70	2.40	2.10	1.80	1.50	1.20	.90	.60	.30	12
15	6.00	4.50	4.12	3.75	3.37	3.00	2.62	2.25	1.87	1.50	1.12	.75	.37	15
20	8.00	6.00	5.50	5.00	4.50	4.00	3.50	3.00	2.50	2.00	1.50	1.00	.50	20
25	10.00	7.50	6.87	6.25	5.62	5.00	4.37	3.75	3.12	2.50	1.87	1.25	.62	25
30	12.00	9.00	8.25	7.50	6.75	6.00	5.25	4.50	3.75	3.00	2.25	1.50	.75	30

The following example will serve to further explain this method:

Name of Section of Score Card	*Perfect Score*	*Estimated Percentage of Perfection*	*Cut*	
1. General Appearance	30	85	4.5	
2. Dairy Character	20	90	2.0	
3. Body Capacity	20	82.5	3.5	
4. Mammary System	30	80	6.0	
Total	100		16.0	Score 84

HOW TO USE THE "SCHEDULE OF CUTS FOR USE IN SCORING ANIMALS"

1. The perfect score for General Appearance is a total of 30 points. By using the "Schedule of Cuts for Use in Scoring Animals", it will be seen that 85% of perfection, or a 15% cut, is equivalent to a cut of 4.5.
2. Dairy Character—90% of a perfect score of 20, or a 10% cut, is equivalent to a cut of 2.
3. Body Capacity—82.5% of a perfect score of 20, or a 17.5% cut, is equivalent to a cut of 3.5.
4. Mammary System—80% of a perfect score of 30, or a 20% cut, is equivalent to a cut of 6.

Total for perfect score = 100, and for cuts = 16.

The score of the animal would therefore be 100 − 16 = 84.

Hint No. 4

Know the characteristics of the breeds of dairy cattle. The basic build of dairy cattle is essentially the same regardless of breed. However, each breed has a place and each has certain characteristics such as size, colour, shape, size and shape of horns, and other minor points that make it distinct from other breeds and animals showing characteristics of mixed breeding. The dairy breeds bred in Canada are Ayrshire, Brown Swiss, Canadian, Guernsey, Holstein-Friesian and Jersey. The population of the Brown Swiss breed is very small in Canada and relatively few Canadians are found outside the Province of Quebec. The remaining four breeds are found in varying numbers in each Province and brief descriptive notes with illustrations will serve to describe each individual breed.

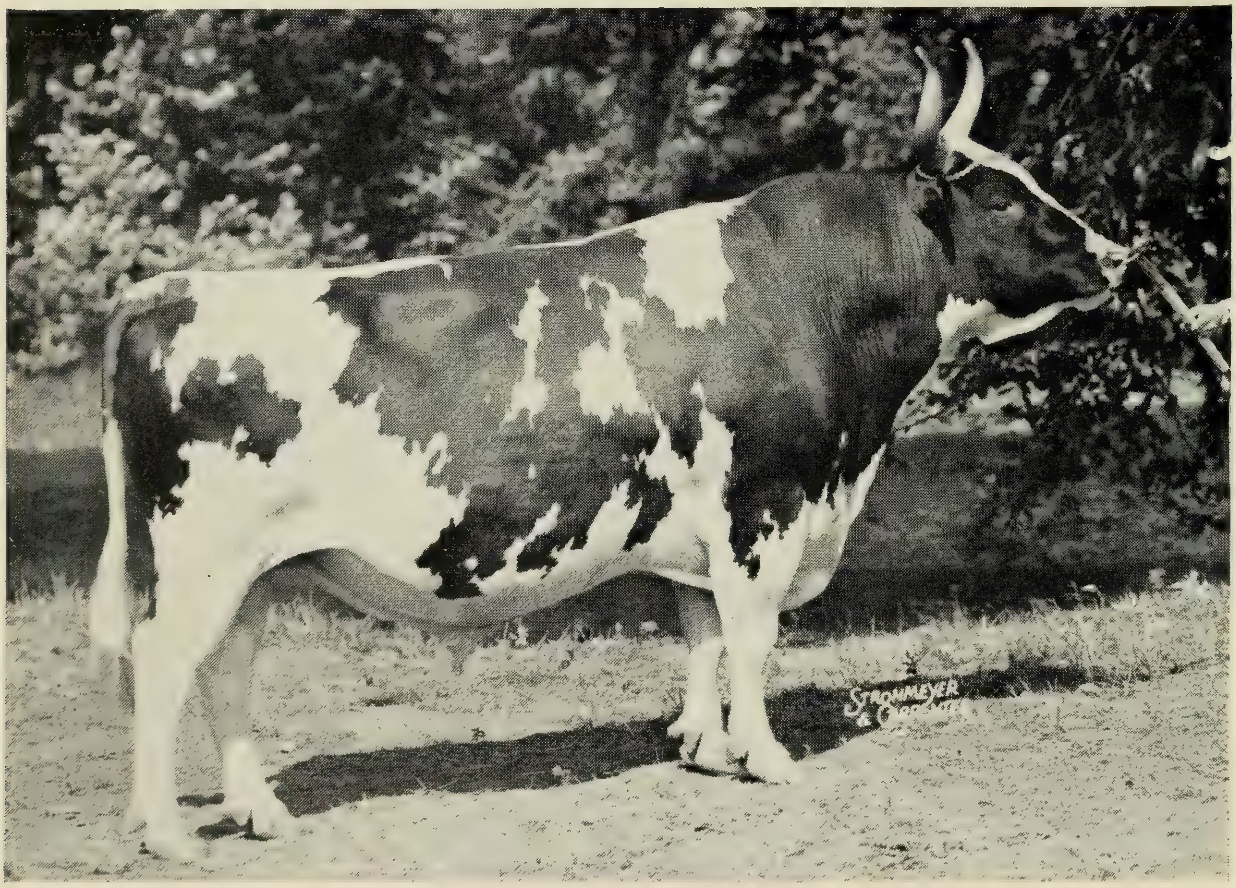
AYRSHIRES

AYRSHIRE CHARACTERISTICS

Colour—Red of any shade, mahogany, brown or these with white, or white, each colour clearly defined. Distinctive red and white markings preferable; black or brindle markings strongly objectionable.

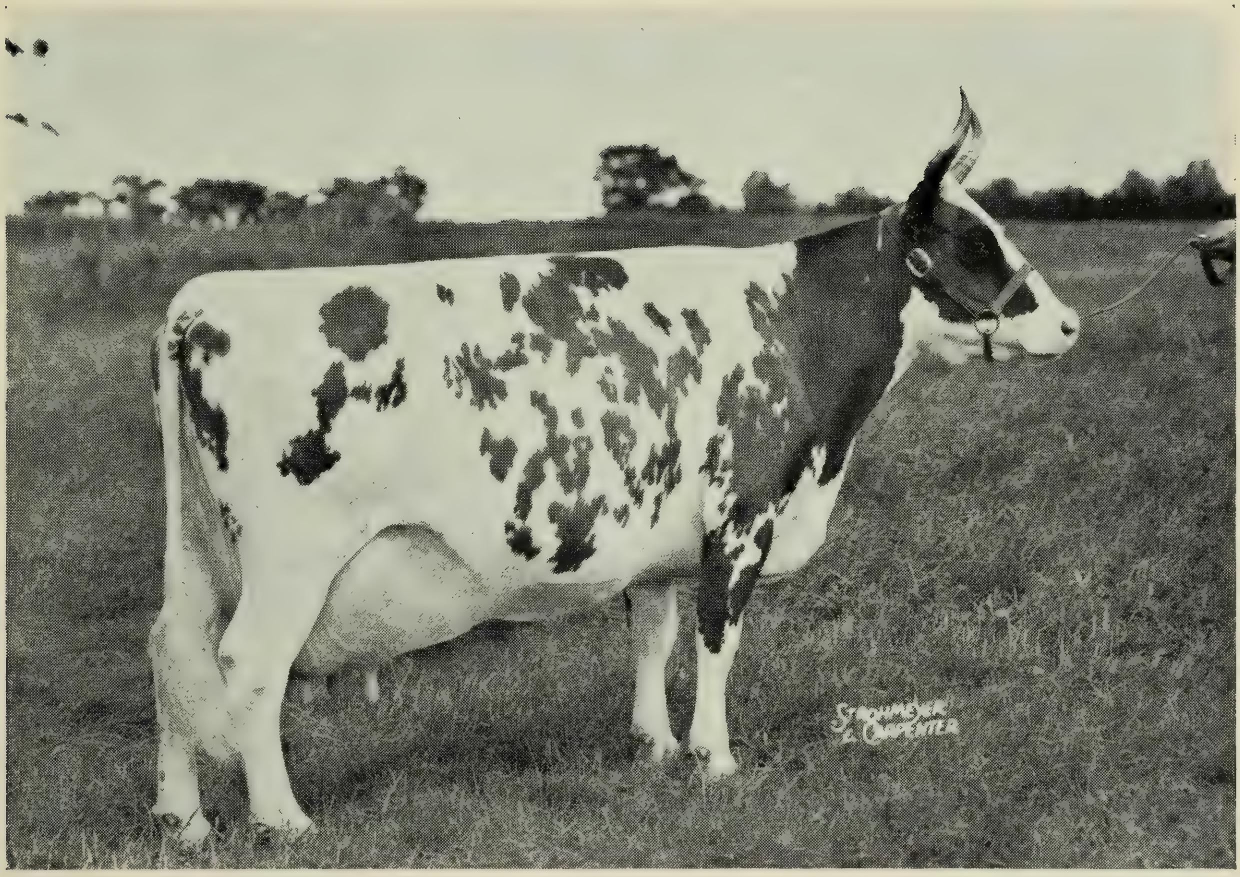
Size—A mature cow in milk should weigh about 1150 pounds. A mature bull in breeding condition should weigh about 1800 pounds.

Horns—Inclining upward, small at base, refined, medium length and tapering toward tips.



AN AYRSHIRE BULL

This illustration of an outstanding Ayrshire bull shows the massiveness, style and quality desired in a mature male. The head is cleancut, the eye bright and alert, the crest prominently developed, but not coarse or beefy. The top line is straight and strong. The bull has constitution, capacity and dairy temperament. Note the exceptionally well set legs of good quality and the deep, solid feet.



AN AYRSHIRE COW

This mature cow shows strength, constitution, capacity, well developed mammary system, and throughout, dairy quality, indicating producing ability. This picture was taken when the cow was eleven years old, and she therefore shows a maturity that is not shown in pictures of cows taken at an earlier age. Wearing qualities and longevity are desirable traits of any cow and are outstanding characteristics of this cow. Somewhat less throatiness, less hook on the hind legs, and a little smoother tail set would improve this cow.

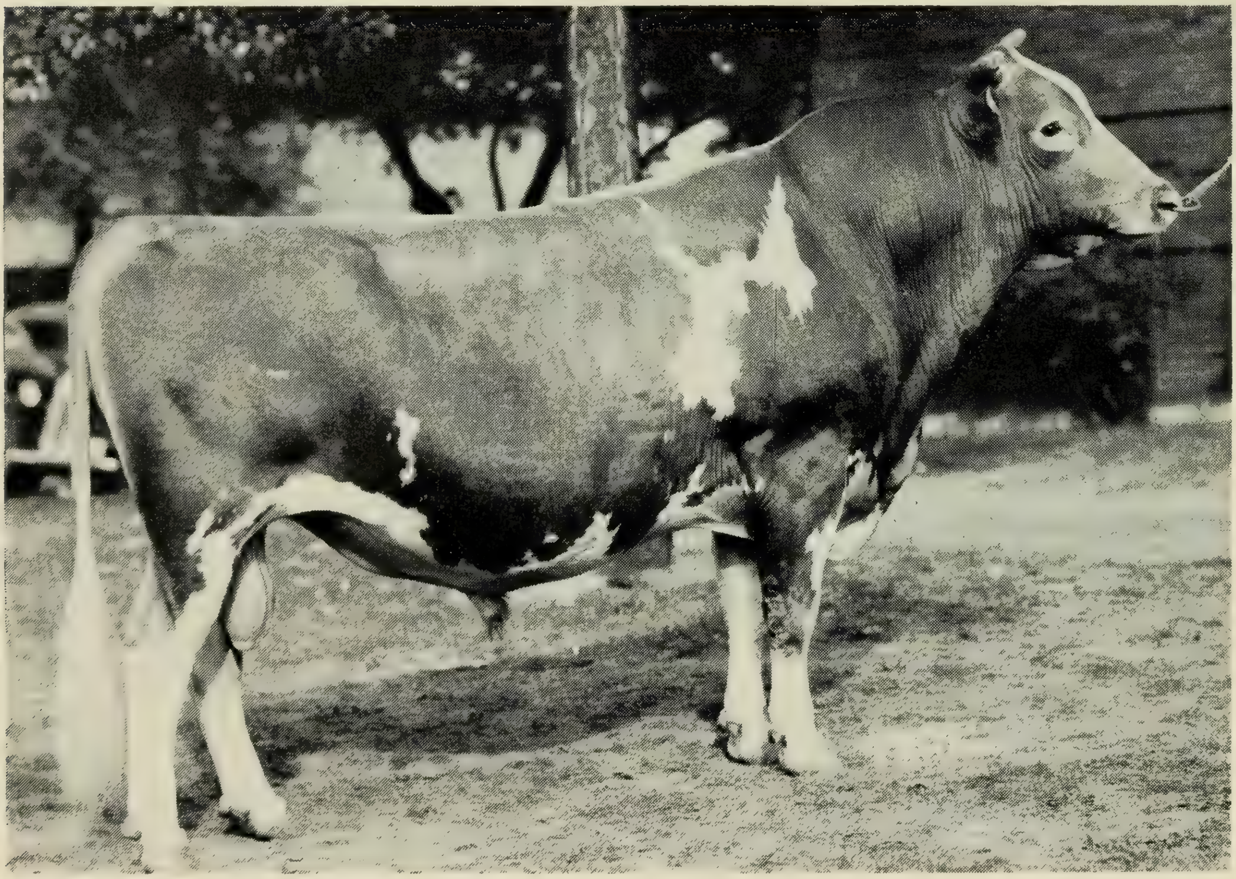
GUERNSEYS

GUERNSEY CHARACTERISTICS

Colour—A shade of fawn with white markings clearly defined, black or brindle markings objectionable. Skin should show golden yellow pigmentation. When other points are equal, a clear or buff muzzle will be favoured over a smoky or black muzzle.

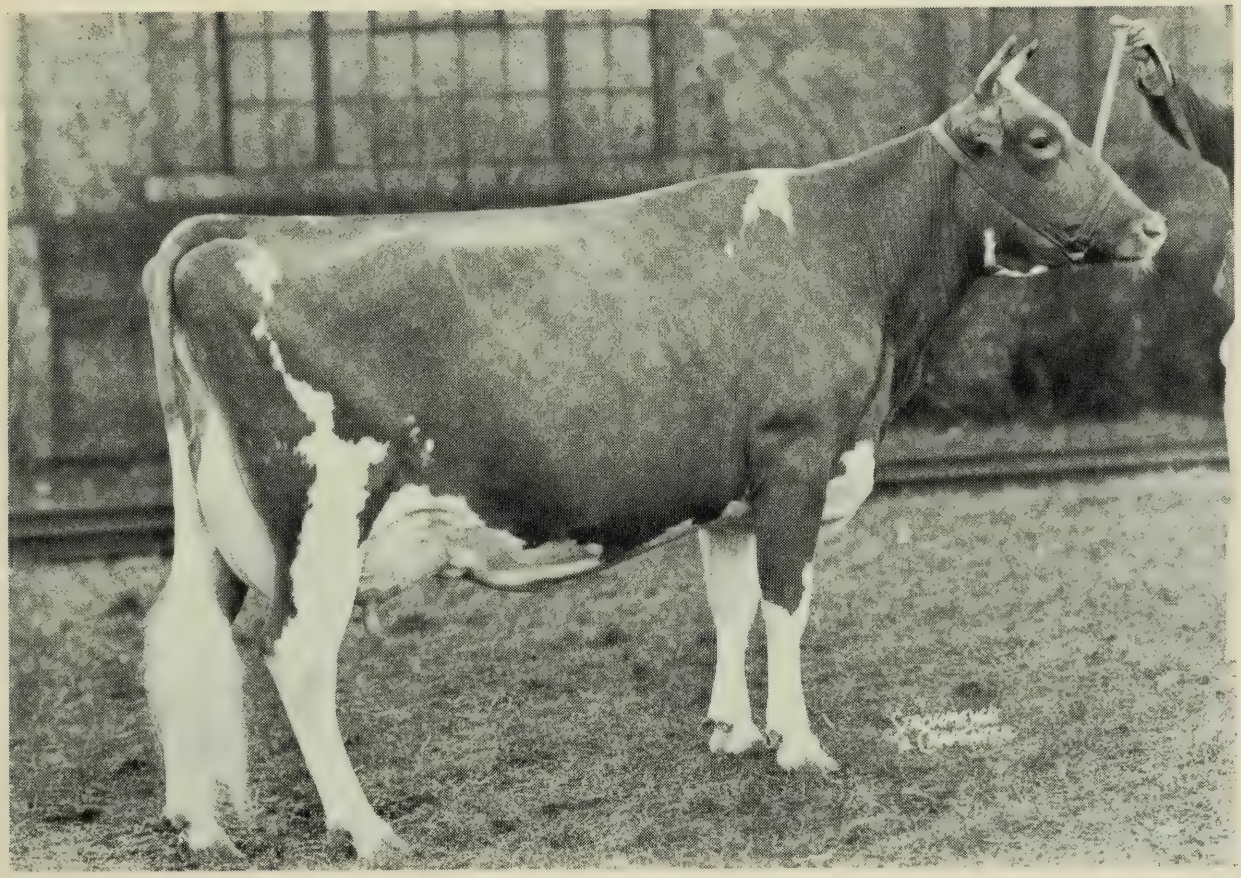
Size—A mature cow in milk should weigh about 1100 pounds. A mature bull in breeding condition should weigh about 1700 pounds.

Horns—Inclining forward, small and yellow at base, refined, medium in length and tapering toward tips.



A GUERNSEY BULL

Note particularly the straight, strong top line, the great heart depth, the excellent quality of bone, and shape of hind leg, and the length and dairy character. The head shows style and character. Somewhat more depth at the rear flank and a little greater length through the lower rear thigh might have slightly improved this bull.



A GUERNSEY COW

A Guernsey cow showing the characteristics of this breed and outstanding dairy temperament wanted in a cow of any dairy breed. A former champion at major shows, she has a very smoothly laid in shoulder, a great constitution and body capacity. The quarter is well nigh perfect. It is long, wide at the pins, high in the thurl region, with no excess fattiness. The legs are of excellent quality and well shaped. The mammary system is almost beyond criticism, with a well attached, outstanding udder and body veins. There is no quartering and the teats are of correct shape and length, and throughout it shows quality and texture. Perfection is hard to attain and this cow might be criticized for a little plainness of head and flatness of loin.

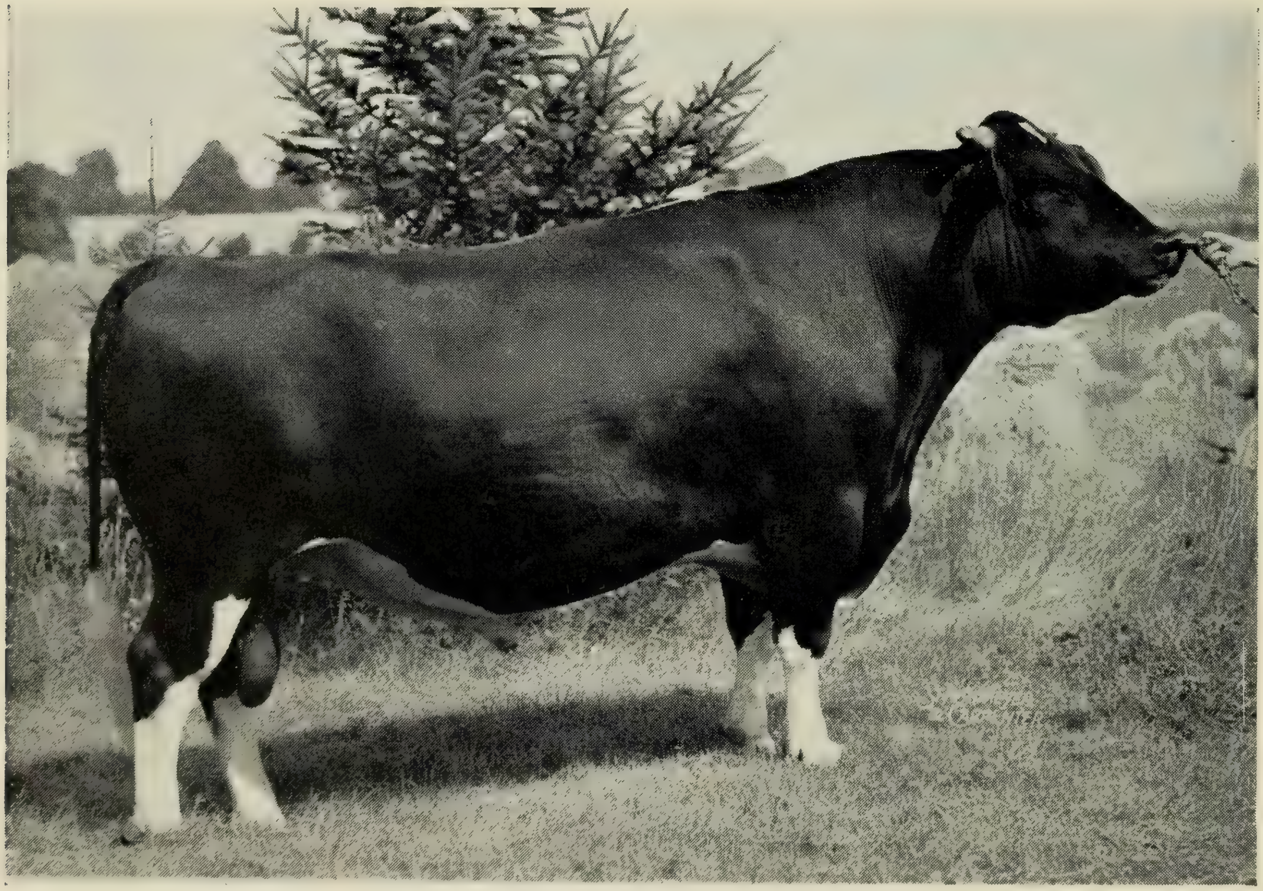
HOLSTEINS

HOLSTEIN CHARACTERISTICS

Colour—Black and white markings clearly defined. Colour markings which bar registry are solid black, solid white, black in switch, black belly, black encircling leg touching hoof, black from hoof to knee or hock, black and white intermixed to give colour other than distinct black and white.

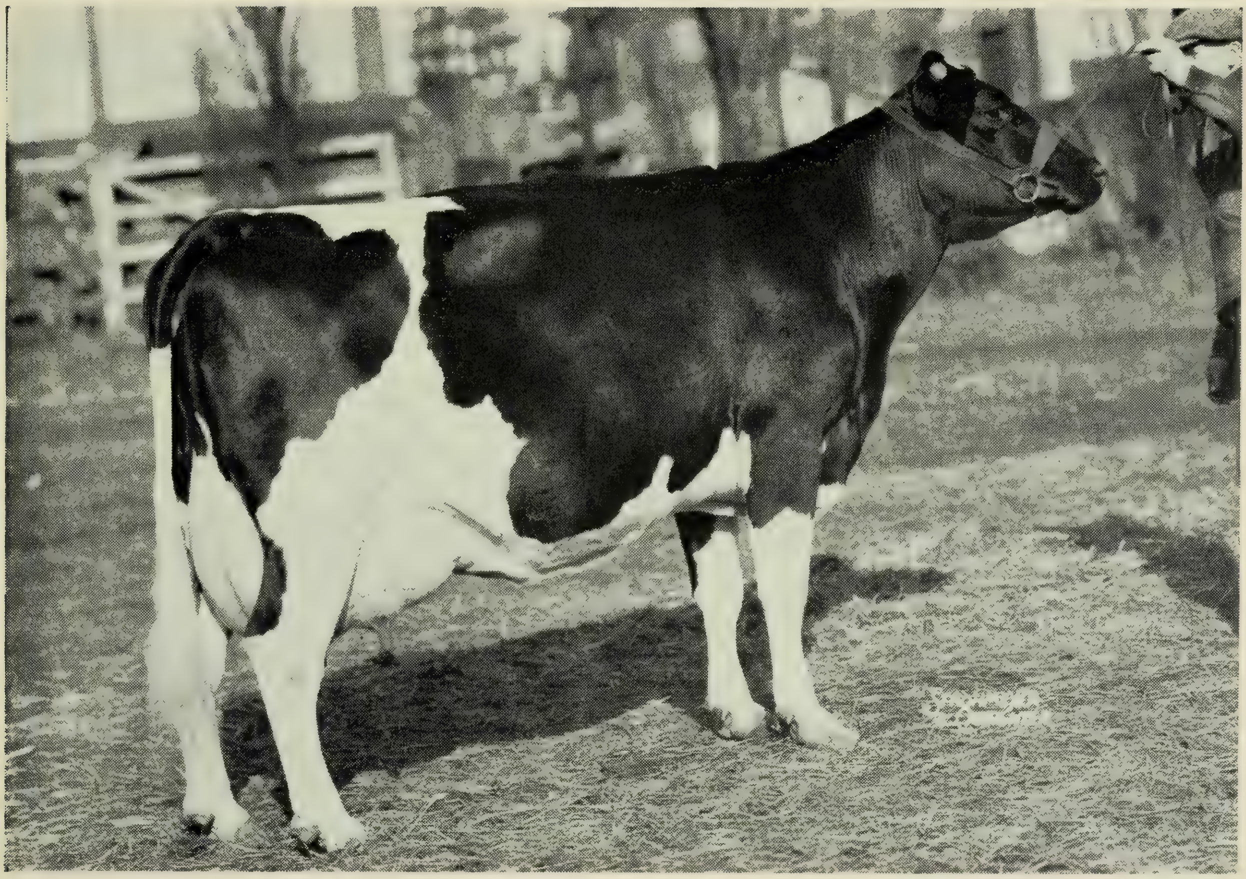
Size—A mature cow in milk should weigh about 1500 pounds. A mature bull in breeding condition should weigh about 2000 pounds.

Horns—Inclining forward, incurving, small at base, refined, medium length and tapering toward tips.



A HOLSTEIN BULL

This bull shows the size, depth, massiveness and dairy character desired in a mature bull. His neck is long, his body deep, and he has a very desirable amount and quality of bone and an alert appearance. A good illustration of masculinity and scale, combined with quality, breed character and smoothness.



A HOLSTEIN COW

This picture illustrates Holstein characteristics and dairy type. The head is stylish, clean-cut and alert, the shoulder blends smoothly into the body, which is deep and capacious. The back and loin are straight and strong, the rump level, and the tail head reasonably smooth. The udder is capacious, well attached fore and rear, and prominent veins are shown on the udder and body. The legs are well shaped with good quality bone.

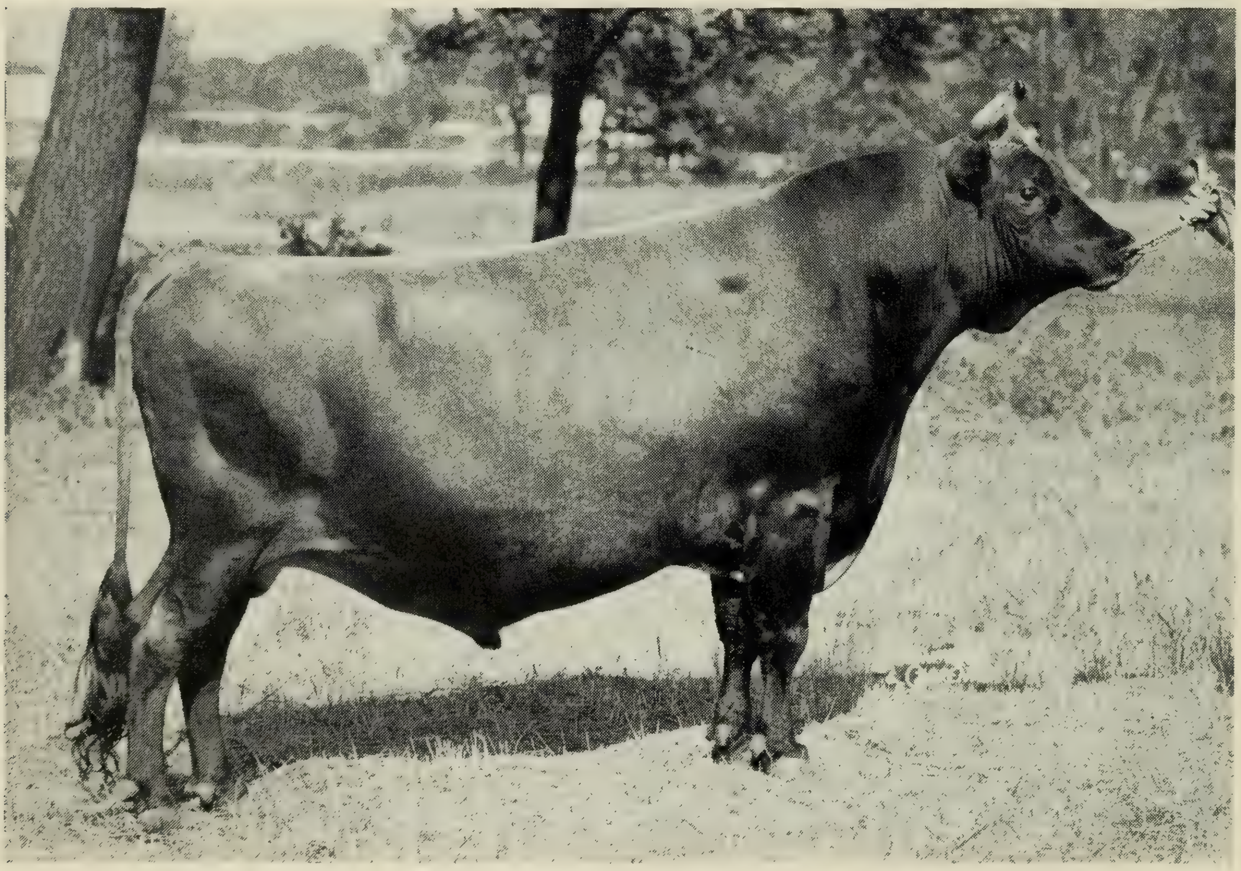
JERSEYS

JERSEY CHARACTERISTICS

Colour—A shade of fawn, with or without white markings.

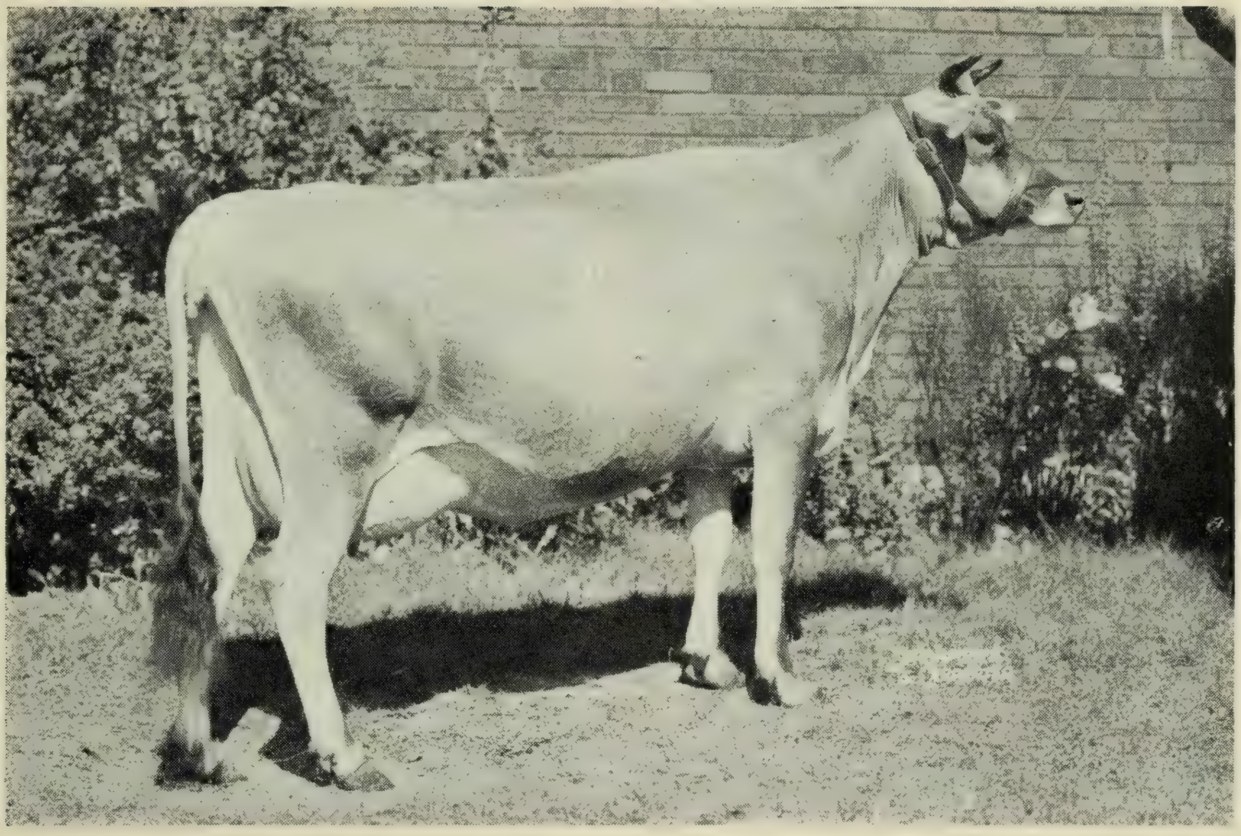
Size—A mature cow in milk should weigh about 1000 pounds. A mature bull in breeding condition should weigh about 1500 pounds.

Horns—Inclining forward, incurving, small at base, refined, medium length and tapering toward tips.



A JERSEY BULL

This bull, a former champion show bull, shows alertness and Jersey character in the head, a strong but not excessively heavy crest, a very great depth at the heart girth, and capacity. The quarter is long and level. The legs show good quality bone, but in the picture the hind legs seem to be set a little too closely together.



A JERSEY COW

This picture shows a Jersey cow with exceptional refinement and character in the head and a smoothly laid in shoulder with great width across the chest floor. Capacity is indicated by the good spring of rib and body depth. The udder carries up well in the rear and is well developed in the front quarters that are firmly attached. The hind quarter is very long, but might show more smoothness on top, particularly in front of the tail head.

GENERAL INFORMATION CONCERNING BREEDS OF DAIRY CATTLE

Breed	*Place of Origin*	*Approx. Wt. of Mature Males (lbs.)*	*Approx. Wt. of Mature Females (lbs.)*	*Colour Markings*
Ayrshire	Scotland	1500–2000	1100–1400	Red and white
Brown Swiss	Switzerland	1600–2200	1100–1500	Brown
Canadian	Province of Quebec	1200–1700	900–1100	Black or dark brown
Guernsey	Island of Guernsey	1300–1800	1000–1200	Reddish fawn with white markings
Holstein-Friesian	Holland	1900–2300	1300-1600	Black and white
Jersey	Island of Jersey	1200–1700	900–1100	Fawn. Some reddish or grayish. Others with white spots.

Hint No. 5

Learn to know the desirable characteristics of the different parts of a dairy animal. The desirable, as well as some of the undesirable, characteristics of dairy type as applied to the parts of an animal are shown in the following illustrations. They do not refer to any particular breed, but to dairy type in general.

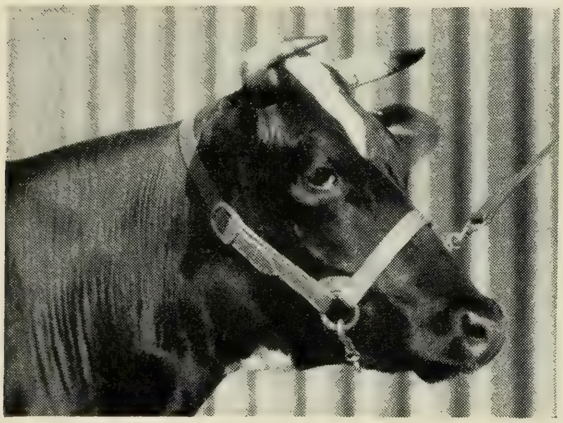
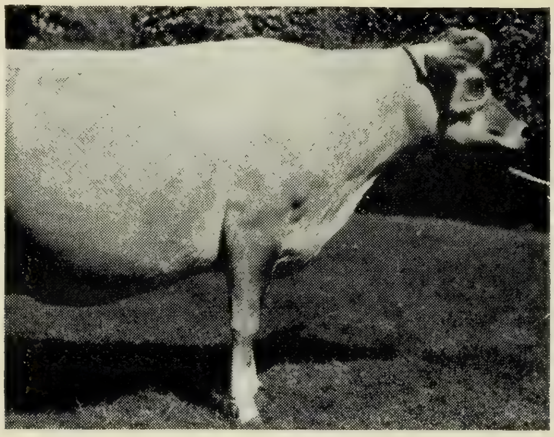
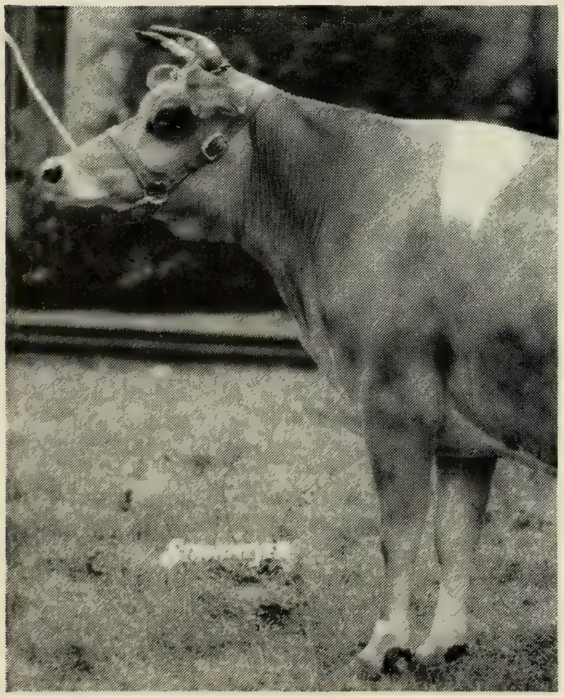


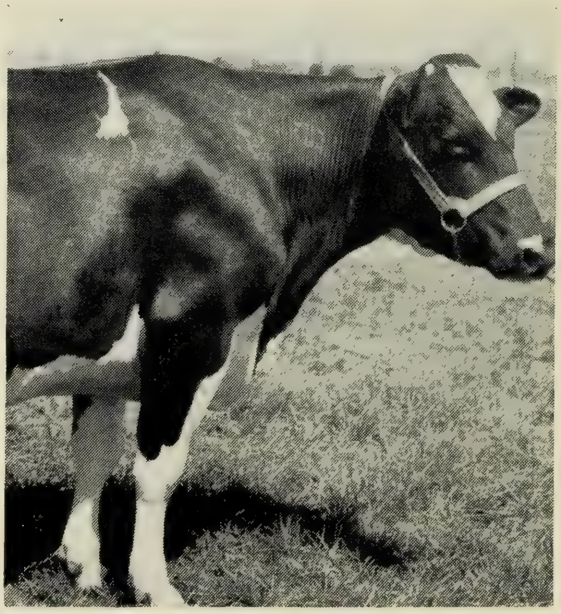
Illustration of a desirable head showing animation, alertness, strength, with refinement and character.



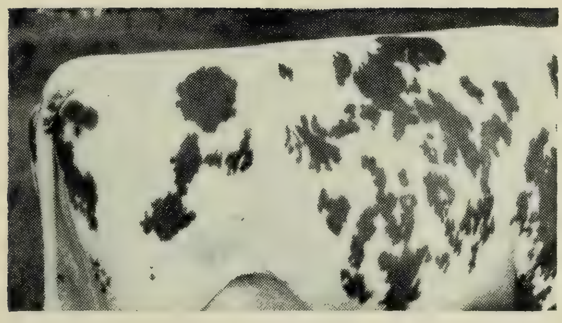
A good body conformation. The shoulder is very smoothly laid in to the body. The heart girth is great as indicated by the depth and the width behind the legs. Great capacity is indicated by the deep barrel. On a basis of perfection, the throatiness, heaviness in the brisket and development of dewlap could be criticized.



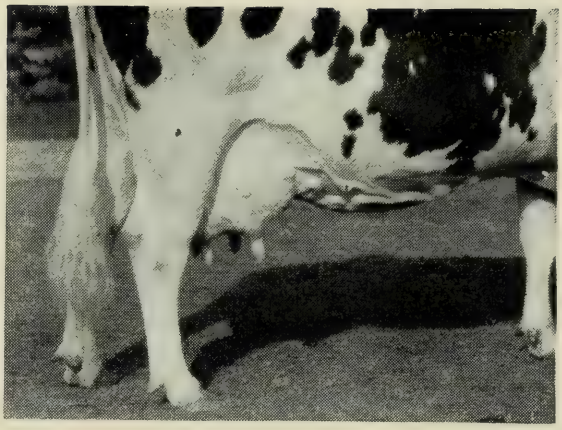
A good front end. The head shows alertness and character, the neck is long and smoothly joined to the body; the shoulder is smooth and well set in the body; the front legs are straight; the knees strong; the feet point straight ahead and show no evidence of toeing out. The only criticism is a little flatness or lack of development in the lower jaw.



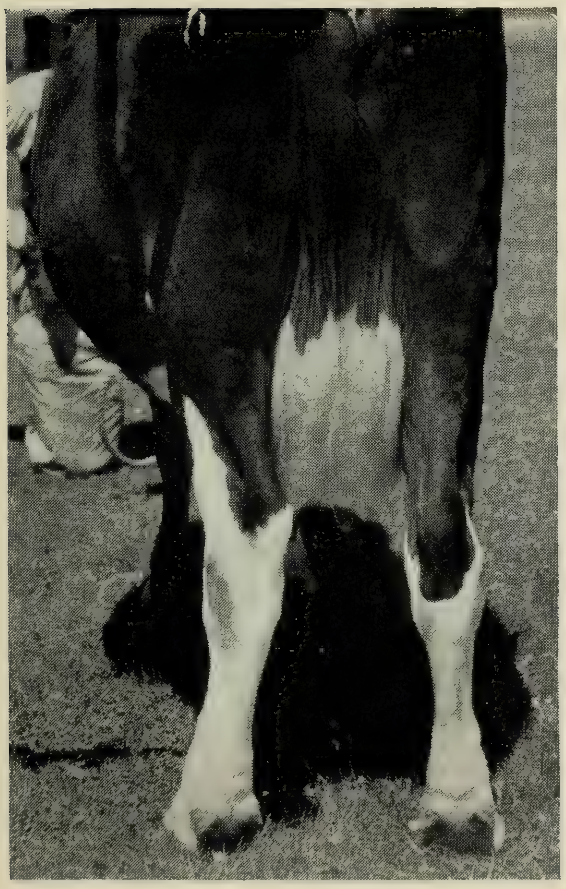
An illustration showing looseness and openness in the shoulder. Note the prominent elbow, the depression behind the elbow and the heaviness at the top of the shoulder.



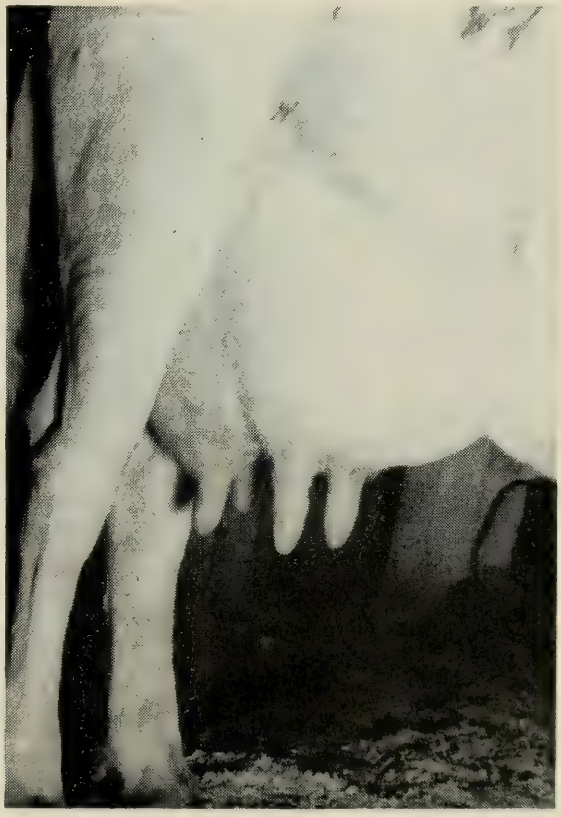
A good top line, strong back and loin, and a long, level rump. The ribs are long and well sprung, giving depth and width. A strong back capable of carrying a heavy cow with capacity and substance.



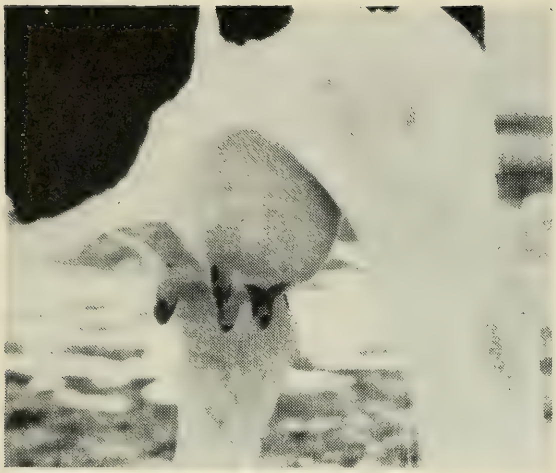
An illustration showing excellent veining on the body and on the udder. The teats hang straight and are placed well under the udder. Note also the well shaped hind leg showing a strong hock and plenty of bone of good quality. The kind of veining, udder, legs and hocks that are desirable on any cow.



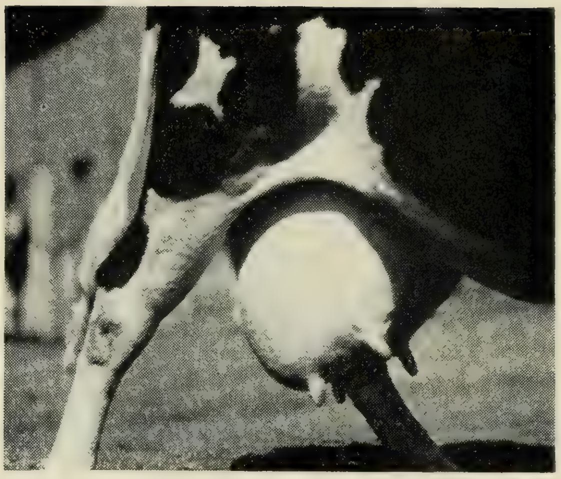
A well attached rear udder. Note the height of attachment and the firm side attachment. The udder is held up well above the hocks. A desirable, durable type of udder.



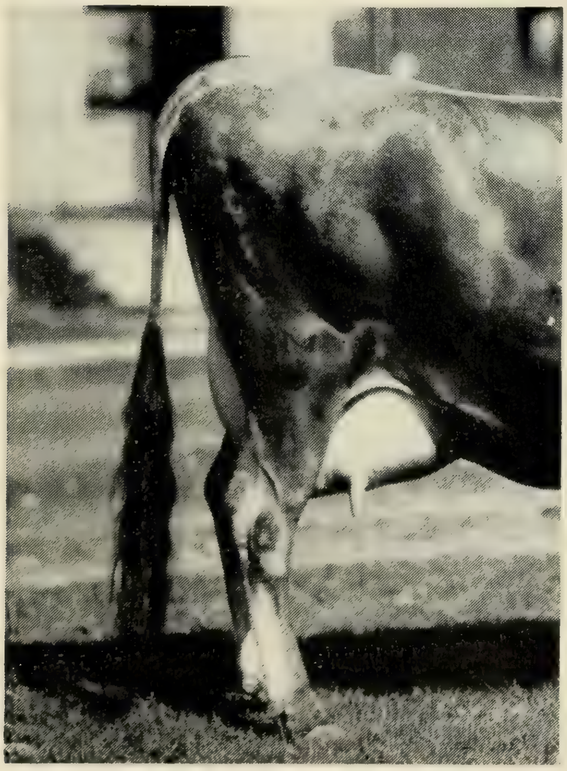
An illustration of a badly quartered udder. Note the cut up appearance from the side and also slight tendency to halve; in all an udder with a rough floor. The front teats hang straight but are rather too long.



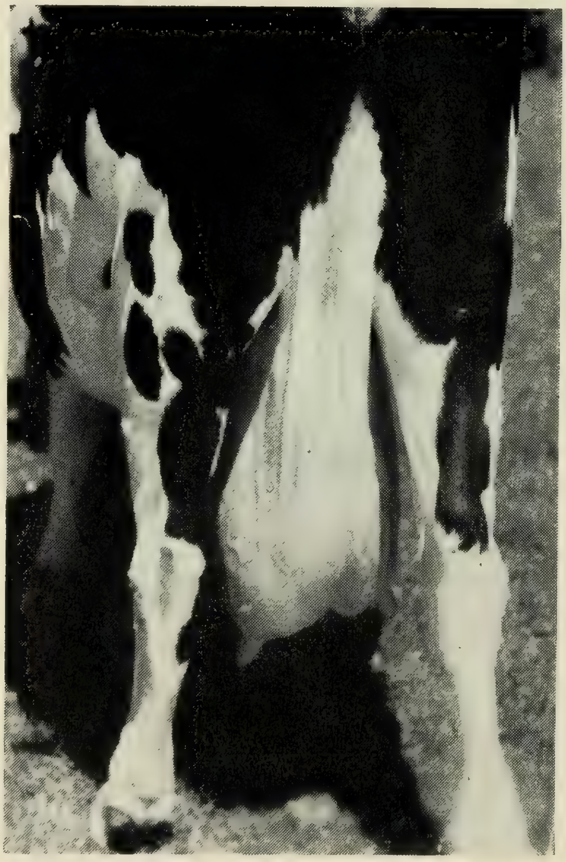
An illustration of an undesirable shape of an otherwise desirable type of udder. The udder is undesirable because of lack of fore udder, considerable evidence of halving, and the front teats are set rather too far out on the side. Desirable because it is well held up above the hocks, shows quality, and teats are of desirable shape and size.



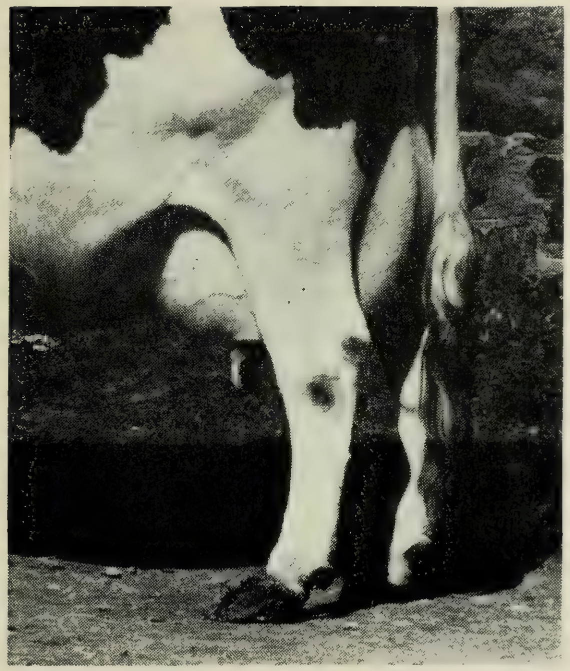
An undesirable type of udder. The front and rear attachments are weak, the udder is short and tilted, with the hind quarters lower than the front. Note also the very short front udder. In all, a most unsatisfactory and unprofitable type.



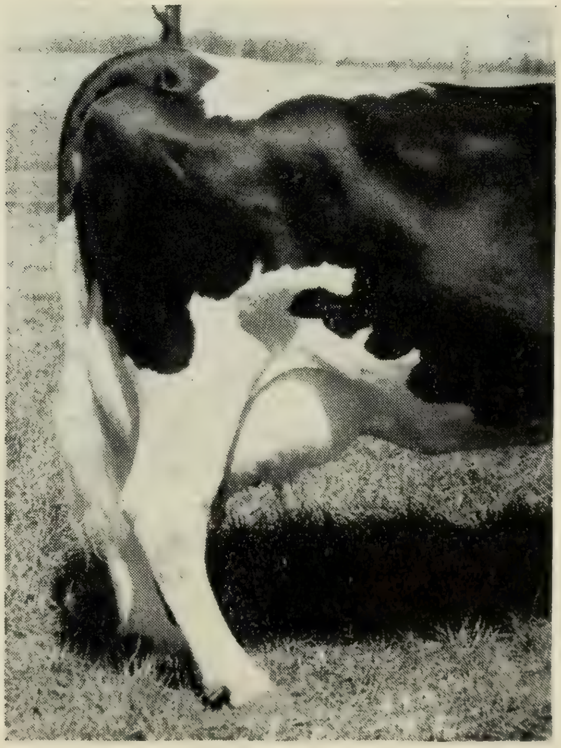
An illustration of an udder showing lack of quality, with teats that are pointed in shape (undesirable), and placed too far out on the side of the udder.



An illustration of a poor rear udder attachment and unbalanced rear quarters. The udder is pendulous and extends considerably below the hocks. A type of udder that is hard to keep in condition, which probably accounts for the unbalanced condition.

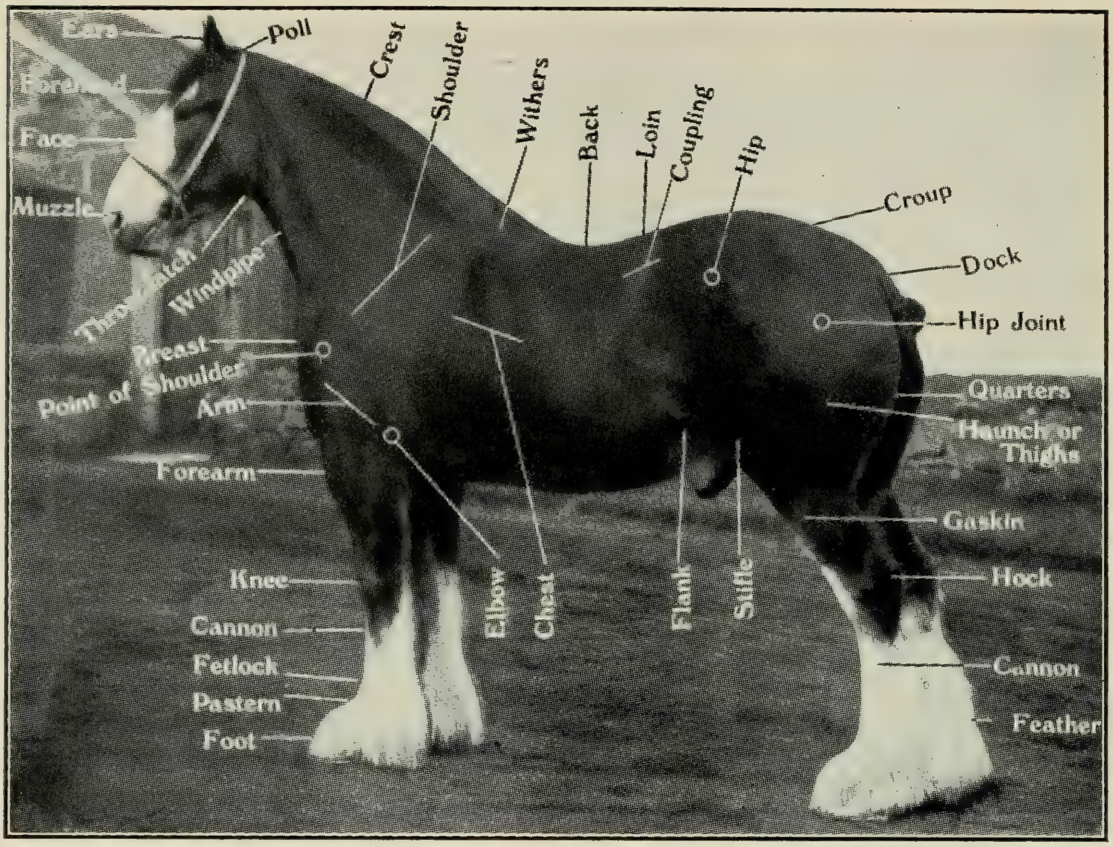


An illustration of a good set of hind leg and foot. The hock is strong, the pastern is not too straight nor too sloping, and the foot is large, deep at the heel and points straight forward. Note also the width between the hocks and the well-shaped, firmly-attached, quality udder.



An illustration of an undesirable shape of hind leg. It is bowed, the hock is small and weak, and the amount of bone appears to be too small for the weight of the cow. Note also the too prominent tail head, the rather flat and low loin and back.

The udder, however, is well developed and is firm and high in rear attachment, also the front udder shows capacity and is firmly attached.

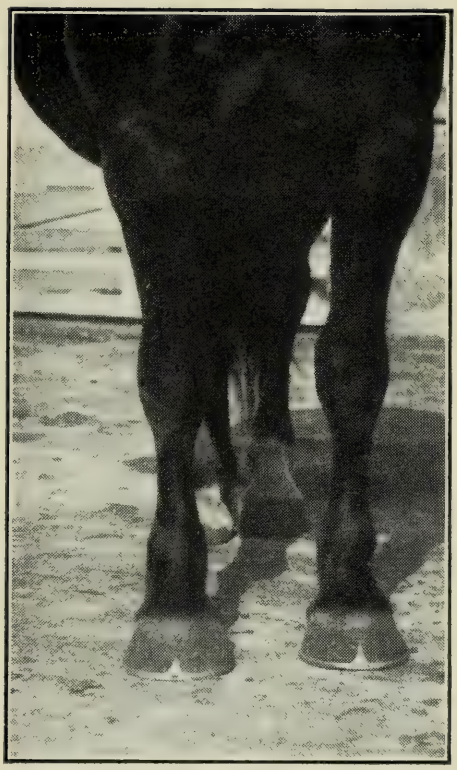


Draft type showing names and location of points

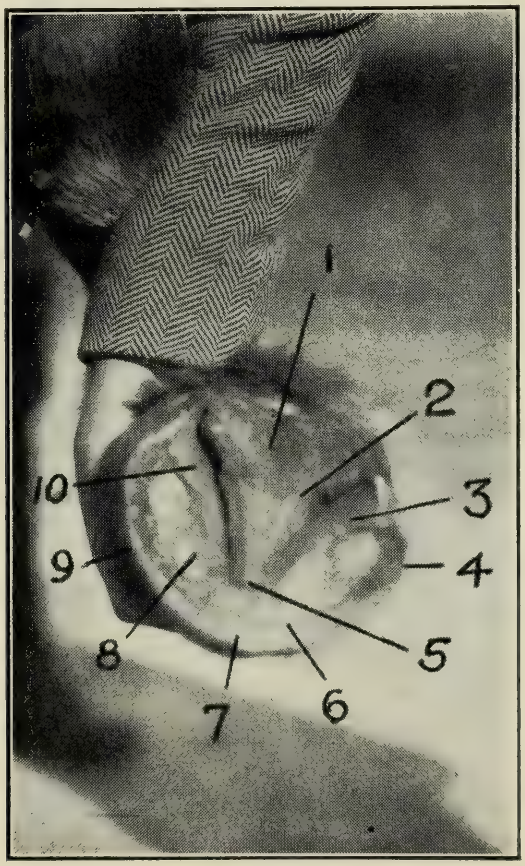
HORSES

Before dealing with the judging of any particular type of horse one should point out the necessity of becoming thoroughly familiar with the points of the horse. In discussing or placing horses one should be careful to use horse terms. Careful study, therefore, and familiarity with the points of the horse as shown in the illustration are essential.

Whether one buys a horse or judges him in the show ring one must have some ideal in mind. In horse judging there are many types and a familiarity with these types and the reasons why certain points are emphasized more than others is essential. A study of conformation consists in the detection of points of superiority and inferiority of structure and in allotting to each their proper significance. The strength of a chain is measured by the strength of its weakest link. Unlike a chain, however, the parts or units of conformation in a horse are not identical. Some are of greater relative importance than others. For example: the four legs of the horse may be likened to the four legs of a table.

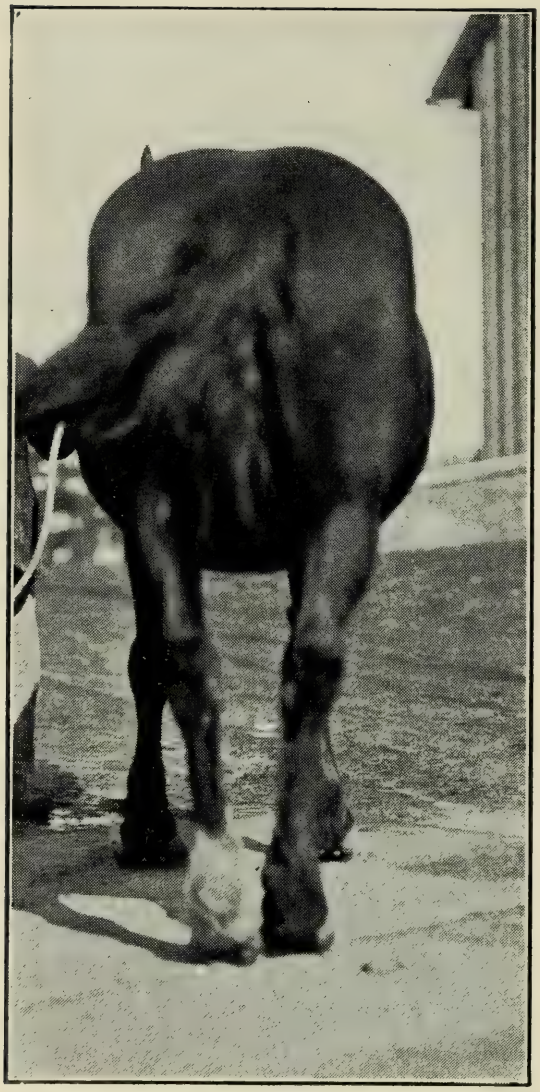


Note quality, shape, size and correct position of the front legs and feet.



A photo of the bottom of a healthy foot. Note the clear outline of the parts.

1. *Central Furrow.*
2. *Lateral Ridge of frog.*
3. *Bar.*
4. *Outer Quarter.*
5. *Apex of Frog.*
6. *White Line.*
7. *Ground Border of Wall of Toe.*
8. *Sole.*
9. *Inner Quarter.*
10. *Lateral Furrow between Frog and Toe.*



A highly undesirable set of feet and legs. Note width at hocks and toed-in appearance in front. A horse with feet and legs of this type cannot go correctly.

A table without legs is not a table and by the same argument a horse regardless of how perfect his body may be is of little value unless he has the correct underpinning to go with it. A special study of the fore and hind legs and their relationship to the horse's body is therefore advisable.

Soundness is most important in judging all classes of horses. The unsoundnesses are very largely confined to the eyes, the wind and the legs. This is a subject in itself and requires a very careful study. Faulty conformation in many cases is the direct cause of unsoundness.

CLASSES OF HORSES

The horse's usefulness depends upon his power of locomotion and whether he moves with power, speed, show or to carry weight will largely determine whether he is a draft, a race, a show or a saddle type horse.

There are many classes and types of horses all of which have been bred to suit some specific purpose. It requires years of experience to become a competent judge of all the various types. A number of the main points taken into consideration in classifying horses are listed below. These form a basis for the classification of horses and ponies.

1. Height; 2. Weight; 3. Form; 4. Quality; 5. Substance; 6. Condition; 7. Temperament; 8. Manners; 9. Colour.

Height: The height is stated in hands and inches and is measured at the highest point of the withers. A hand is four inches. Fractions of the hand are expressed in inches, as 15 hands 2 inches or 15–2. This is a very important consideration in judging horses where a certain definite height is specified. In judging draft horses it is not so necessary to know the exact height.

Weight: The height and weight combined usually determine the scale or size. The weight for light and heavy draft horses varies. At some fairs horses up to 1500 pounds are classed as light drafts, others up to 1600 pounds and at the Royal 1700 pounds.

Form: The general outline determines whether the horse is smoothly turned or angular, massive or lithe, low set or rangy. One of the main differences between a Hackney, a Standard Bred and a Hunter is body form.

Quality: This refers to the texture and finish. It is indicated in the quality of hide and hair, the bone and general conformation.

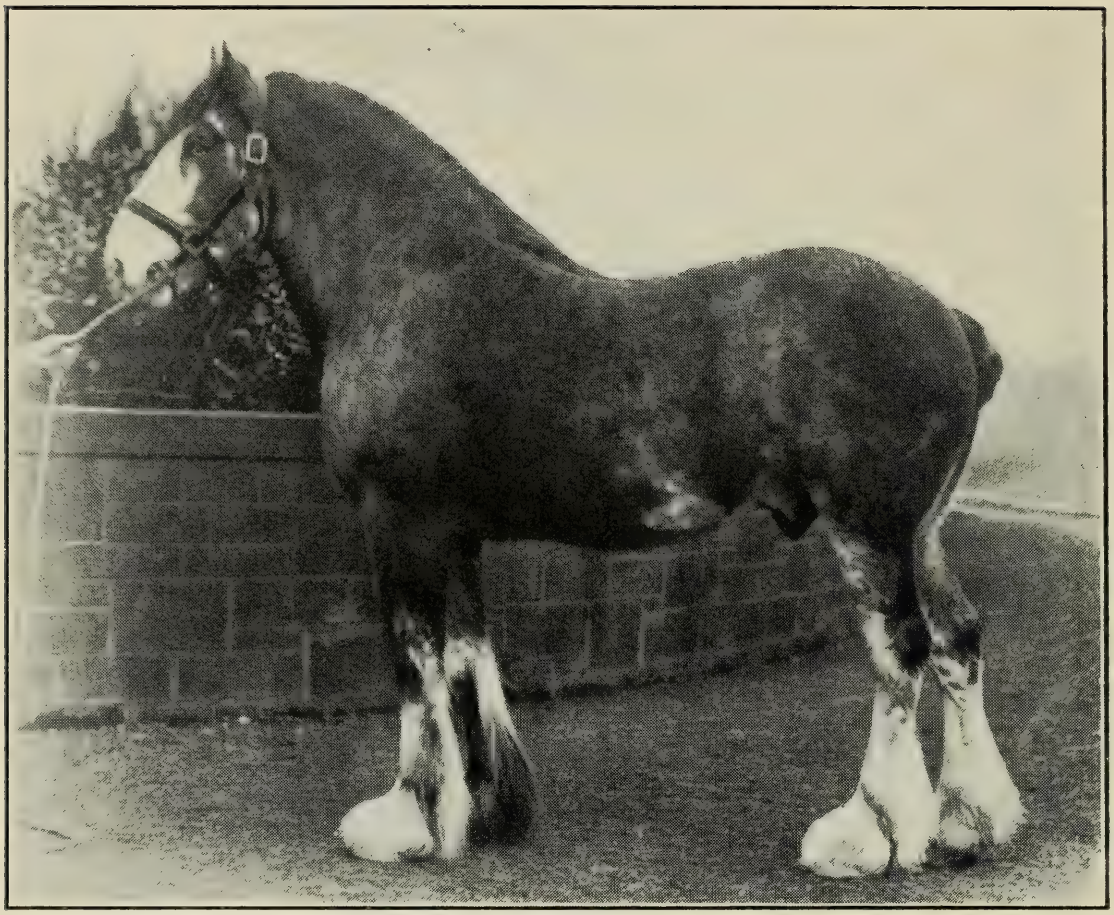
Substance: This refers, as the name implies, to the amount of bone and body development.

Condition: In the ordinary draft horse this refers to the difference between a horse carrying a good deal of fat and one that is lacking. In the race horse it has reference to the difference between the trained against the untrained horse.

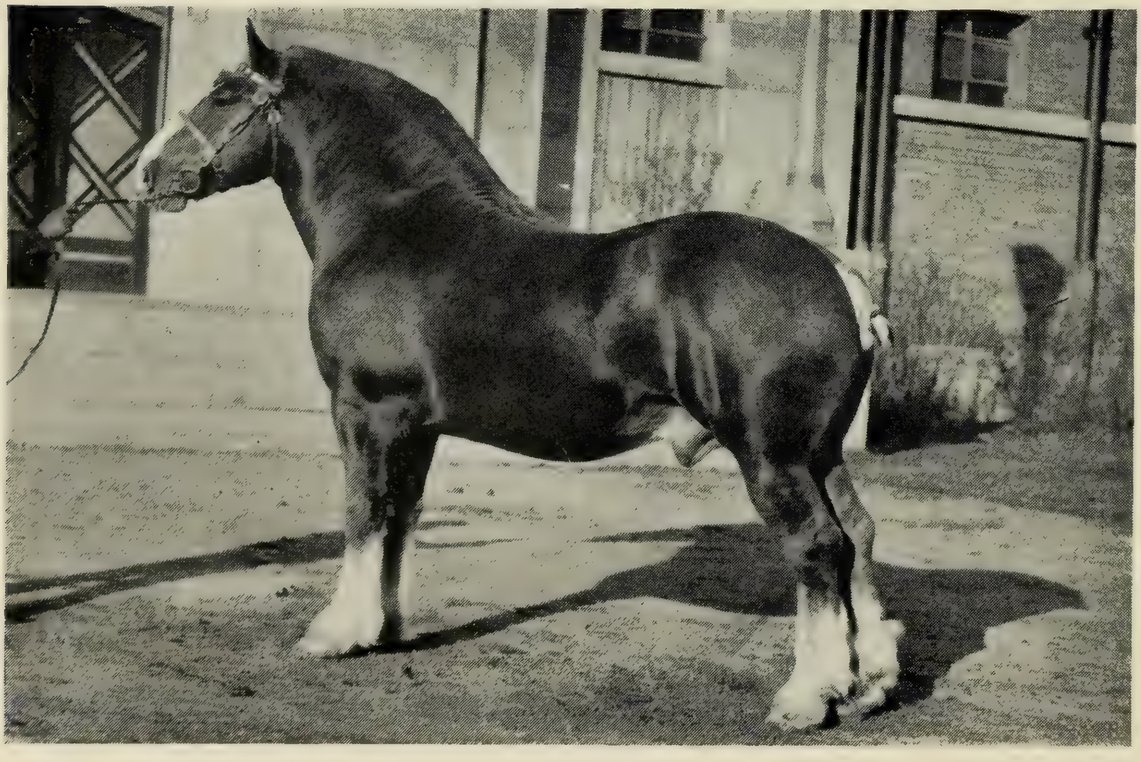
Temperament: There is a difference in temperament in the various types. The lighter breeds, of necessity, have a more highly developed nervous system which fits them for their purposes.

Manners: Manners or schooling count for a great deal in the value of all horses. The value of the horse in some cases is fixed on what he can do and how well he can do it.

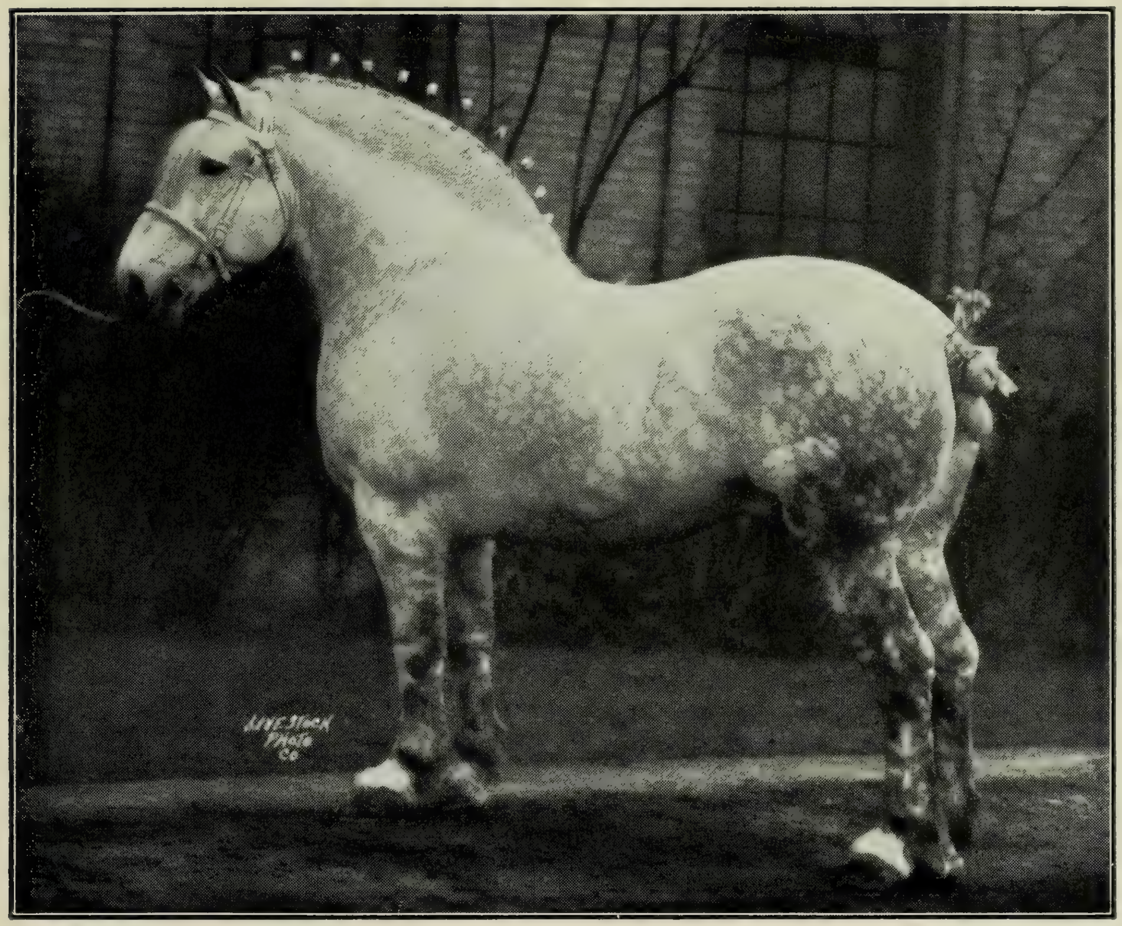
Colour: "No good horse is a bad colour" is an oft repeated saying and while colour may not influence judging in the show ring it might affect the market value of the horse considerably.



Clydesdale Stallion. This horse has a high degree of breed character, draft type and quality.



A noted prize winner and breeding Belgian stallion.



*A prize winning Percheron stallion and a great sire.
Photo taken at the close of the breeding season.*

CLASSIFICATION OF BREEDS OF HORSES AND PONIES

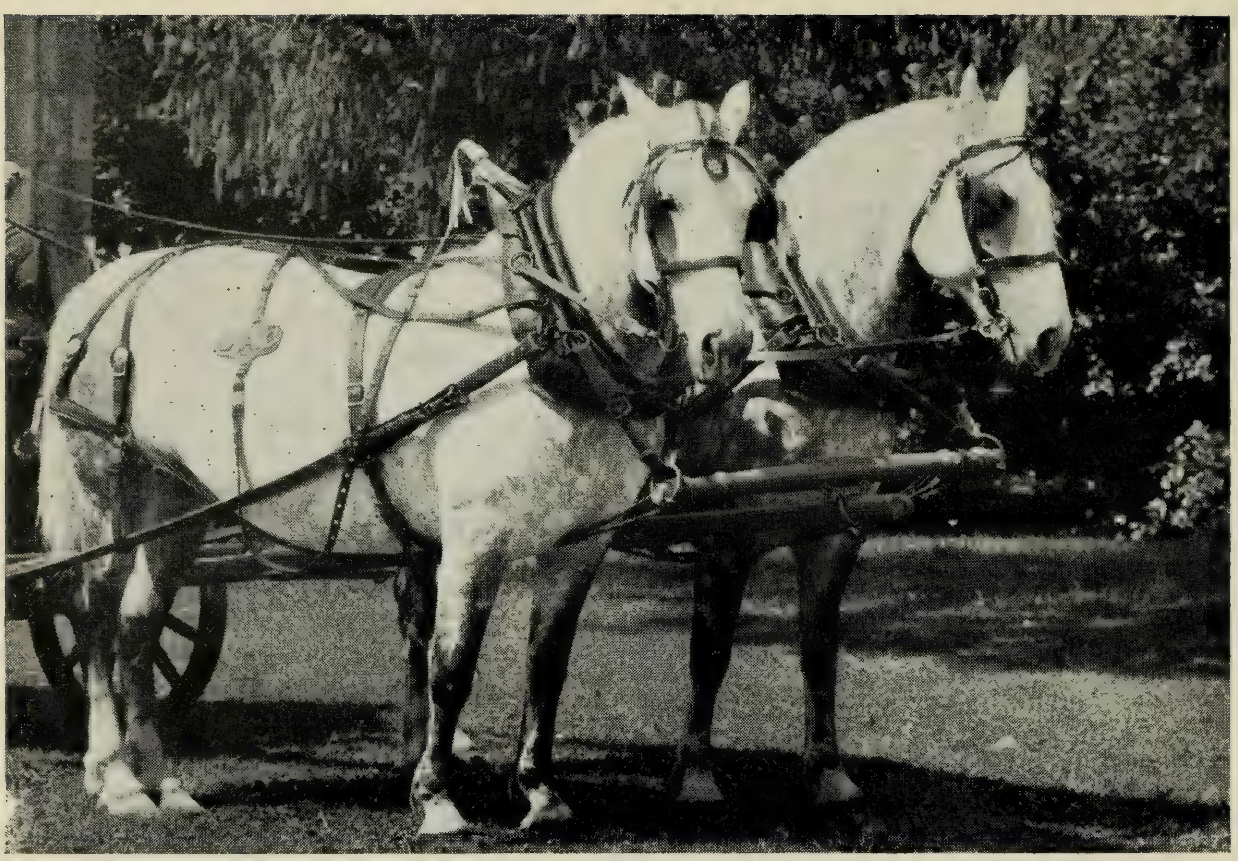
Horses are divided into a number of types or groups suitable for the same general use.

Draft Type: The breeds comprising this type are: Clydesdales, Percherons, Belgians, Suffolks and Shires.

In addition to horses of this breeding we have: General Purpose, Wagon and Express Type.

These generally weigh from 1200 to 1500 pounds and as the name implies are used for a number of purposes, such as delivery horses, milk wagon horses, etc. Horses shown in this class are usually not of pure breeding but the result of crossing heavy and light horses. The Canadian, French and German Coach, and Cleveland Bays might be classed as General Purpose or Wagon types.

Carriage or Heavy Harness Type: The Hackney is the best example of this type. There is a considerable difference in height and weight in horses of this type. The colour is also variable but good, sound, solid colours such as bays, browns and chestnuts are preferred.



A well matched pair of Wagon or General Purpose type. Weight—3100 pounds.

This pair are full sisters, sired by a Percheron stallion and out of a Hackney bred mare. This is only one of the crosses that have produced satisfactory horses of this type.

Roadster or Light Harness Type: The Standard Bred or the American Trotter is an example of this class. Here again the height and weight are variable and also the colour. The term Light Harness is used because of the fact that horses of this type are used for harness racing when a comparatively light type of harness is used.

Saddle and Hunter Type: Thoroughbred, Irish Hunter, American Saddle, Palomino, Arabian.

Horses of this type are used for show purposes and for pleasure riding.

The American Saddle Horse is sometimes classified as a fine harness horse, especially in the United States.

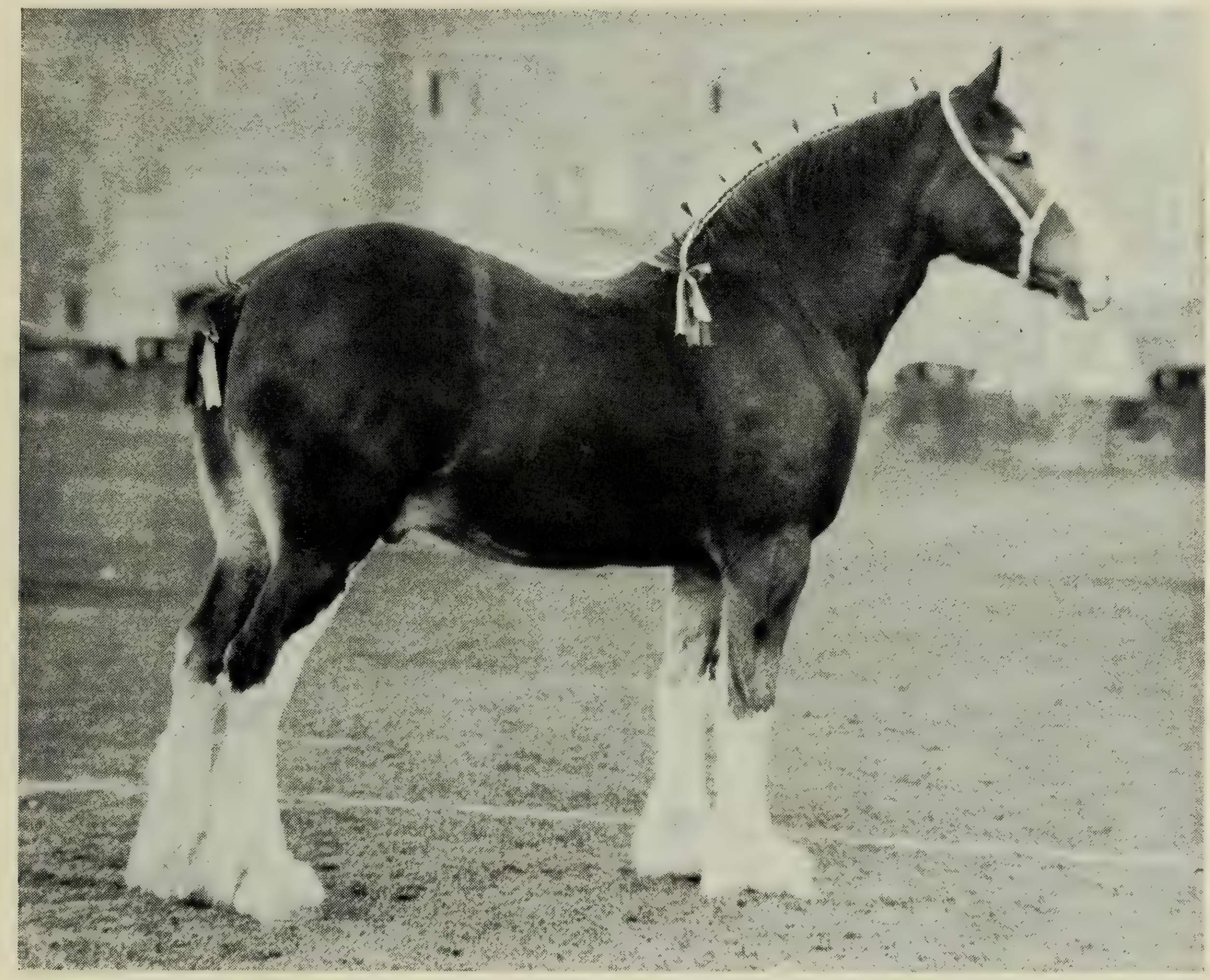
Half breds: (half Thoroughbred). They are frequently used for riding purposes because they have a little less "steam" than a Thoroughbred. There is a classification at many fairs for the produce of Thoroughbred stallions mated with non-registered approved mares and also at some shows for mares suitable to produce Hunters. The second and third crosses usually make a very satisfactory Hunter.

Coach stallions are sometimes mated with Thoroughbred mares to produce Hunters.

Ponies: A pony must be 14 hands 2 inches or under and, of course, show pony type.

Hackney, Welsh, Exmoor, Dartmoor and Shetland are the more common breeds of ponies.

The Hackney and Welsh are of the heavy harness or carriage types.



Three-year-old Clydesdale gelding. Note the substance and quality. He weighed 2200 pounds as a finished horse.

JUDGING DRAFT HORSES

(Based on order of observation)

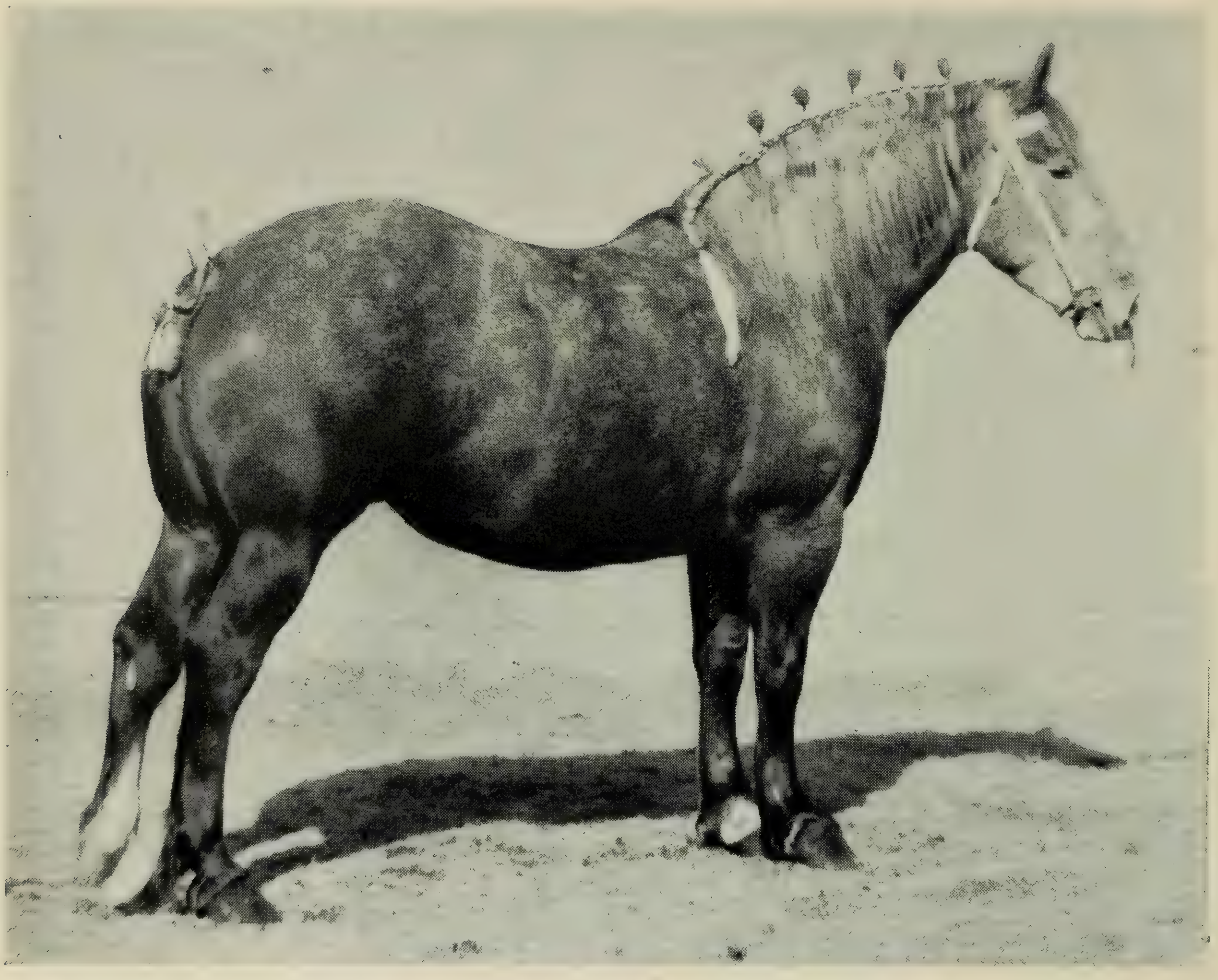
It has been stated that no draft horse is a good one unless he has the cardinal points of good feet and legs, good walking action and a robust constitution or, in other words, he must have action, size and quality.

General Appearance: The conformation or blending of the parts of the horse should be noted. Not only should the parts be well formed individually but they must fit and blend with each other in order to give a pleasing and symmetrical appearance. Not all parts are of equal value.

Head and Neck and Shoulders:

Head—Of medium size with medium sized pointed ears; forehead broad and flat; eye full, prominent and mild; nasal bones straight; nostrils large, firm and flexible; muzzle rather small; mouth of medium depth; lips compact; muscles of cheek well developed and prominent; space between branches of lower jaw wide at angles.

Neck—Attached to the head in a graceful manner, not thick and heavy at the throat, medium length, deep and full where it joins the body, being continuous with the withers without any line of demarcation; crest nicely arched, the whole neck well and prominently muscled, surmounted by a full mane of good quality.



A typical three-year-old Percheron filly. Note the quality of bone, size and shape of feet.

Shoulder—The shoulder should make a 45° angle and be heavily muscled. The breast should be broad and well muscled.

Back and Middle:

Back—Straight and short; loin broad, strong and heavily muscled.

Middle—A good heart girth is essential to ensure working and feeding ability. This is indicated by the width of chest, spring and depth of ribs. A horse gets his capacity from his depth, spring of rib and length underneath. Fat has a tendency to make the back look shorter and the depth of middle greater.

Long-backed horses are usually short ribbed. Condition and methods of feeding influence the appearance of the horse's middle. Sufficient attention is not always paid to his feeding quality.

Hind Quarters:

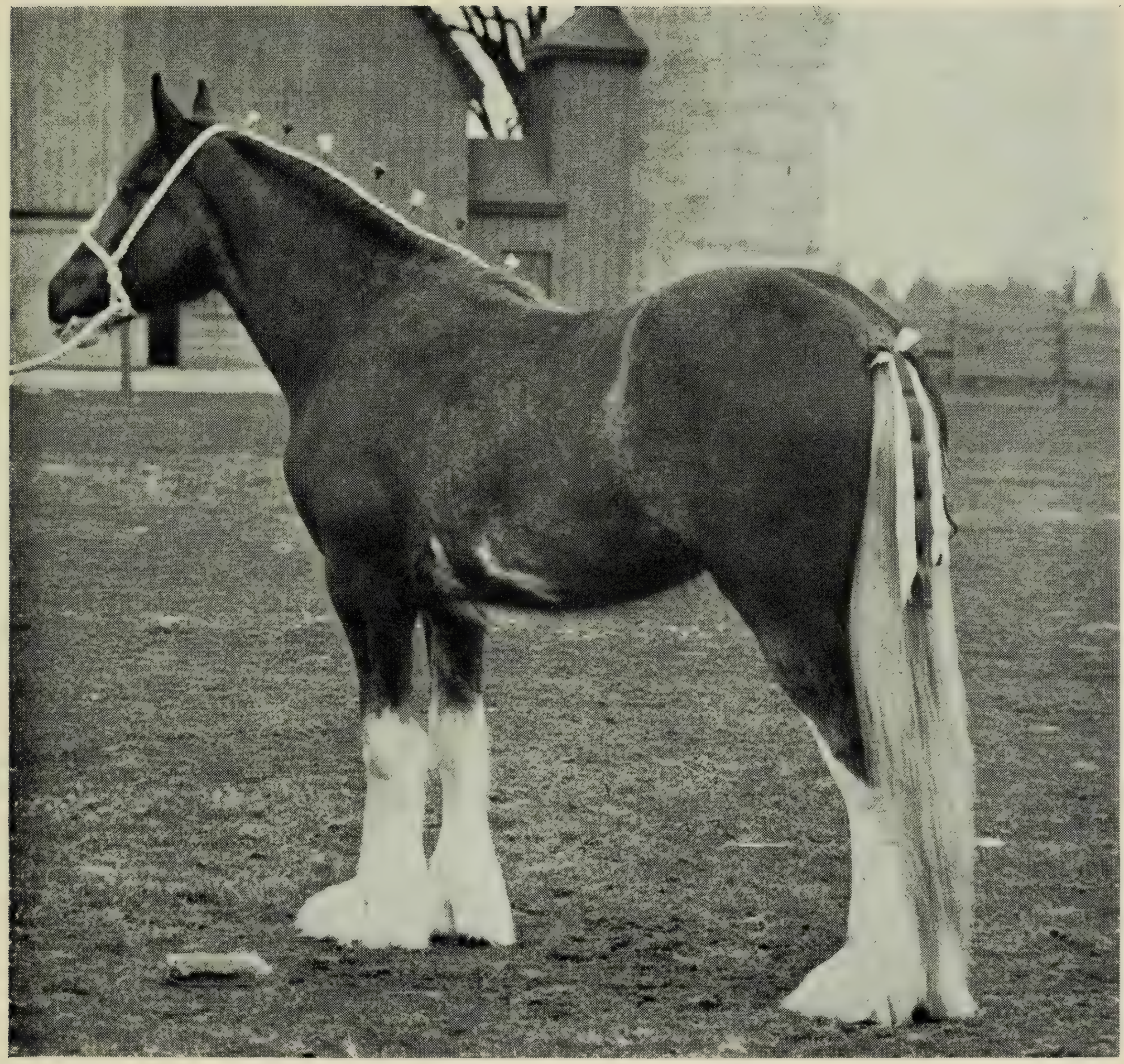
Croup—Long, well muscled, dock coming out fairly well up and well clothed with straight and not too coarse hair.

Stifle—Strong, compact and well muscled.

Gaskin—Strong and heavily muscled.

Fore Feet and Legs:

A horse's value depends on his power of locomotion. Special attention must therefore be given to the feet and legs.



Clydesdale filly, two years old. Note the femininity, quality, substance and correctness of underpinning.

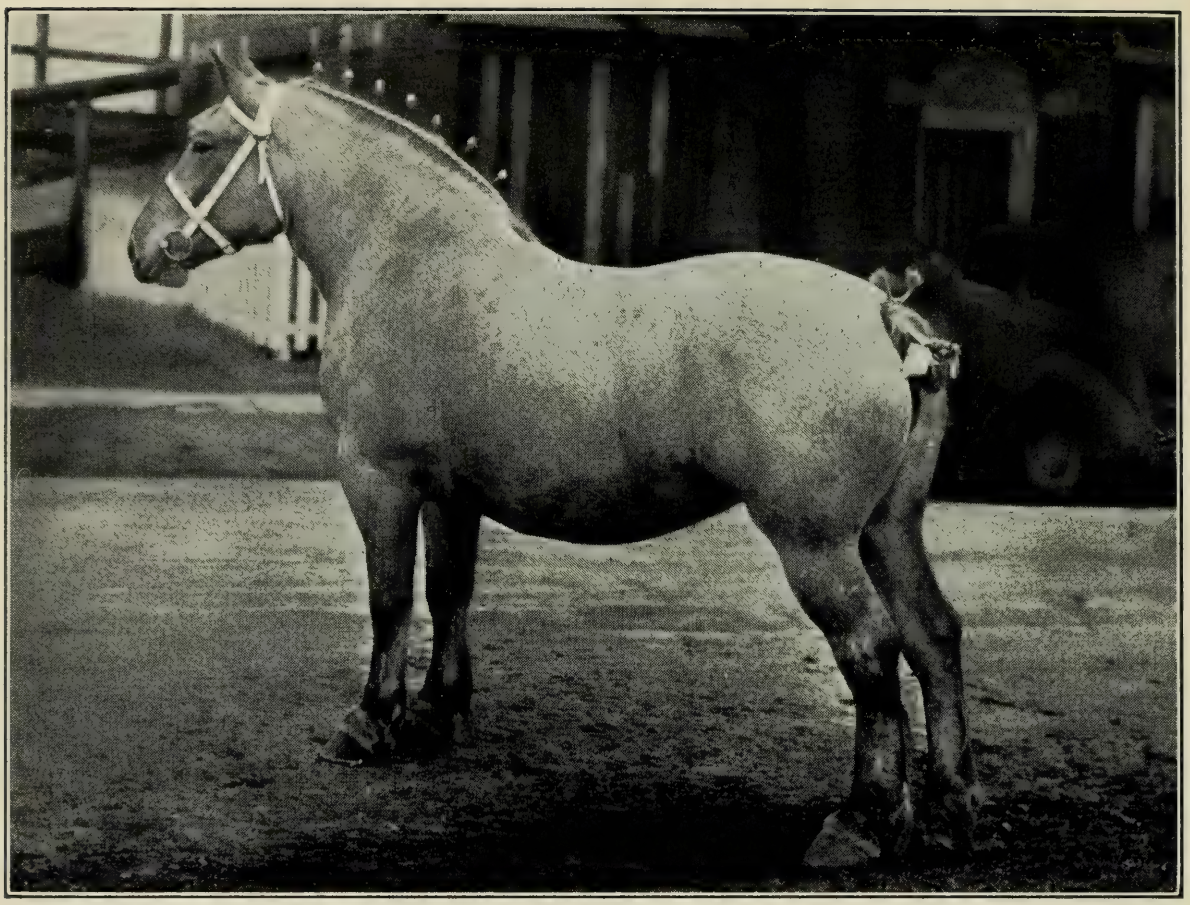
Forelegs—About two-thirds of the weight of the horse is carried on the front legs. For this reason one should pay considerable attention to the front legs and front feet. The legs should be set properly under the horse, neither too wide apart nor too close together. Either extreme is undesirable. Viewed from the front a vertical line downward from the point of the shoulder should fall upon the centre of the knee, cannon, pastern and foot. From the side view a vertical line downward from the centre of the elbow joint should fall upon the centre of the knee and pastern joint and back of the foot.

Forearm—Large and strong; rather short and well muscled.

Knee—Straight, deep, broad and strong.

Knee to Foot—Quality of bone is essential. Cannon bone broad, strong, flat and flinty; ligaments and tendons well developed and not tied in below the knee. Fetlock joint large and strong; pastern of medium length and well marked obliquity (45°). The pasterns are the shock absorbers to the horse's feet and body. Hair or feather, if present, straight, fine and silky.

Forefoot—Large, round, with strong and deep wall, frog well developed and strong; heels broad and strong. Flatness, brittleness and contracted heels are the three most common defects in horses' feet. Feet should be of equal size.



A typical Belgian filly. A prize winner.

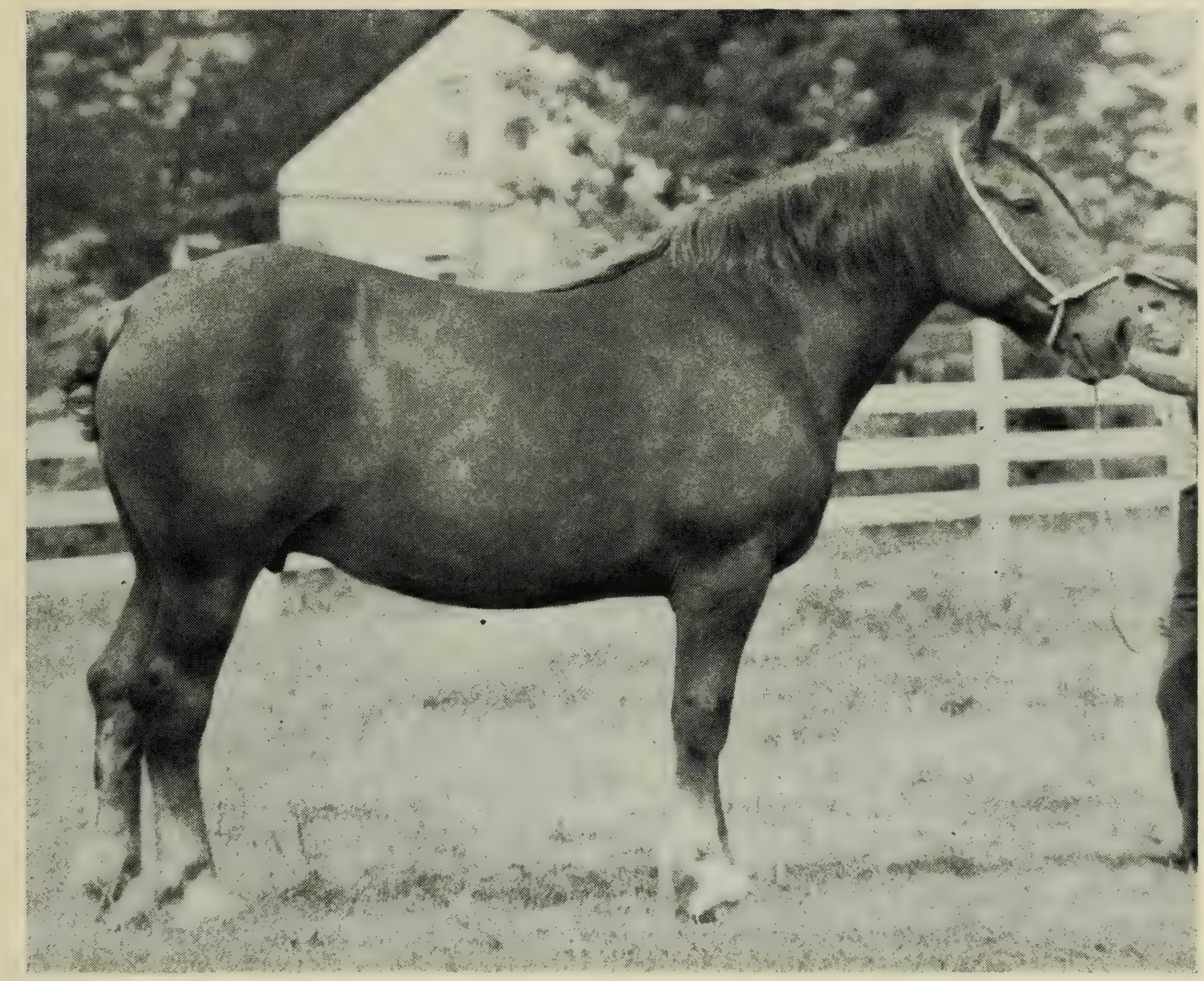
Hind Legs and Feet:

Hock—Special attention should be given to the hocks. They are under constant strain during work. The hocks should be large, deep, broad, as viewed from the side, clean cut and angular. The horse must stand with hocks fairly well together. From the side view a vertical line downward from the point of the buttock should touch the back of the hock, the back of the cannon to the ground. The length from stifle to the hock should not be too great.

Hock to Foot—Cannon bone of reasonable length, broad, flat and strong; ligaments and tendons well developed and strong, and not pinched in below the hock; fetlock joint large and strong; pasterns of medium length and well marked obliquity. Hair or "feather", if present, straight, fine and silky.

Hind Foot—Usually smaller and more concave in the sole than the forefoot. Walls strong and moderately deep; frog well developed and strong; heels broad and strong. Feet should be of equal size.

N.B.: The beginner frequently refers to the "hind" hocks. It is only necessary to use the term hocks.



A typical Suffolk brood mare.

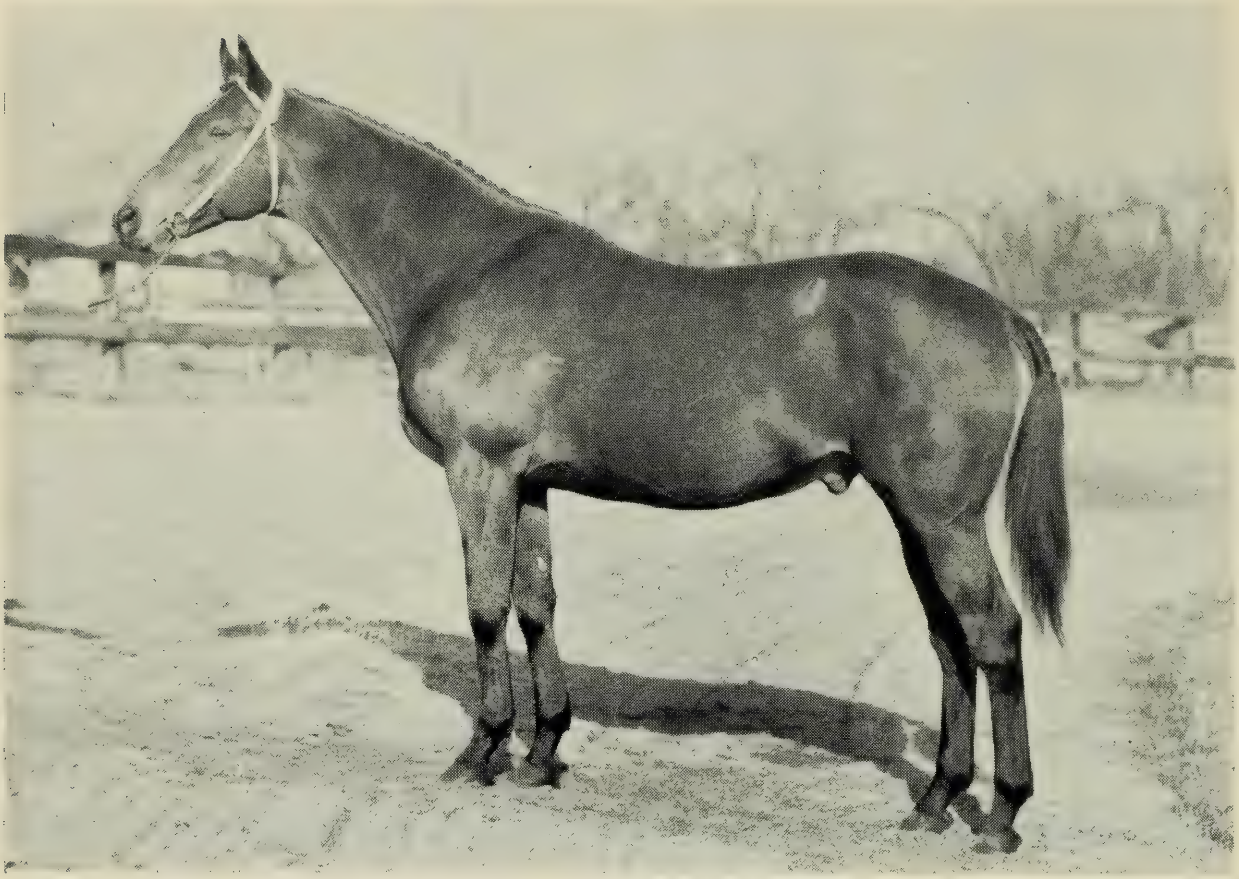
Action and Temperament:

Action—In criticizing the walk or trot of the draft horse the action may be noted from two points of view, before and behind and in close decisions from the side. As he approaches the judge, the horse should carry his head high and the stride should be regular. The feet should be lifted clear of the ground and placed down evenly. There should be no tendency to wing or paddle.

As the horse walks away note the action of the hock and hind leg. The flexion in this region should be free and straight. The legs, both fore and hind, should flex freely at the knees and hocks, for a rigidness of movement of these is indicative of defects of some kind. Close hock action either at the walk or trot is most desirable. Big, thick, weighty horses may not go quite so close behind.

The draft horse on trotting should go level, straight and regular.

Temperament—Energetic, docile, not nervous. Horses that are well fed and get only a reasonable amount of exercise frequently show considerable spirit at the halter but this need not necessarily mean the horse has not a good temperament.



Thoroughbred stallion of approved Hunter type. This horse might be criticized for lack of obliquity and fineness of the shoulders.

JUDGING HUNTER HORSES

In judging Hunter horses the essential things to consider are size, type, quality and action. Not one of these is enough in itself, but a combination of these is vital to a first class Hunter.

Hunters are of three types, light weight, middle weight, and heavy weight. The essentials of all three are the same. The type is the same but there is a corresponding increase in bone and substance as well as height and weight.

The shoulders and withers are important in judging Hunter horses. The shoulder should be unusually long, sloping and extended into high wedge shaped withers which have the effect of placing the saddle well back and holding it in that position. (The centre of gravity of the horse is just back of his front legs.) This type of shoulder and withers tends to put the rider farther back on the horse and there is less tendency for the horse to stumble. In other words there is "much horse" in front of the rider. This type of shoulder and withers permits a secure and comfortable sitting position without the spreading of knees and thighs occasioned by the full made harness horse.

The back should be short. A "family horse" back is not desirable in a Hunter.

The hind quarters should be long and properly moulded, well muscled and special attention should be given to the hocks because these take considerable strain when the horse is put to the jump.

JUDGING THE HUNTER HORSE (Based on order of observation)

General Appearance:

A proper blending and correlation of the various parts.

Form—Body, compact.

Quality—Bone clean, hard, with plenty of substance; tendons and joints sharply defined; hide and hair fine. Ruggedness and durability without coarseness.

Temperament—Expression of keenness, docility and quick perception.

Head and Neck and Shoulder:

Head—Refined; forehead straight; ears erect and medium sized; eyes, clear and prominent.

Neck—Long, narrow towards the poll and clean cut at the throat. Neck must not be thick and meaty and is well set in the shoulders.

A lofty carriage is objectionable in the Hunter.

Shoulder—The shoulders are an important consideration in judging Hunters. The upper border of the neck should pass into high, wedge-shaped withers. Most of the best Hunters are high in this region.

Body:

Chest—Must be deep. Too much width at chest is not desirable. It often means bulky shoulders.

Ribs—Deep and long and reasonably well sprung for heart and lung capacity.

Back—Must be well ribbed up; medium length; well muscled over kidneys. A long back is undesirable.

Loin—Broad, well muscled.

Hind Quarters:

Hips—Smoothly turned.

Croup—Tail set on a long well muscled quarter.

Thighs and *Gaskins*—Neatly turned and muscular.

Fore Feet and Legs:

The cannons, fetlocks, pasterns and feet demand special attention.

Fore Feet—Round, uniform, straight; frog large, elastic; heels wide, full; horn dense and smooth.

Pasterns—Moderate length and slope (45°).

Cannons—Bone must have substance—broad, flat; tendons sharply defined indicating quality.

Legs—Correct position of fore legs as viewed in front—a perpendicular line from the point of the shoulder should fall upon the centre of the knee, cannon, pastern and foot. From the side, a perpendicular line dropping from the centre of the elbow joint should fall upon the centre of the knee and pastern joints and back of hoof.

Hind Feet and Legs:

Hind Feet—Usually not quite so large; other characteristics same as front feet.

Pasterns—Moderate length and slope.

Cannons—Bone broad, flat; tendons sharply defined.

Hocks—Must be broad, deep from front to back, clean in outline and covered with a thin skin; the face or front of hock should be wide at top, narrowing into cannon bone at base.

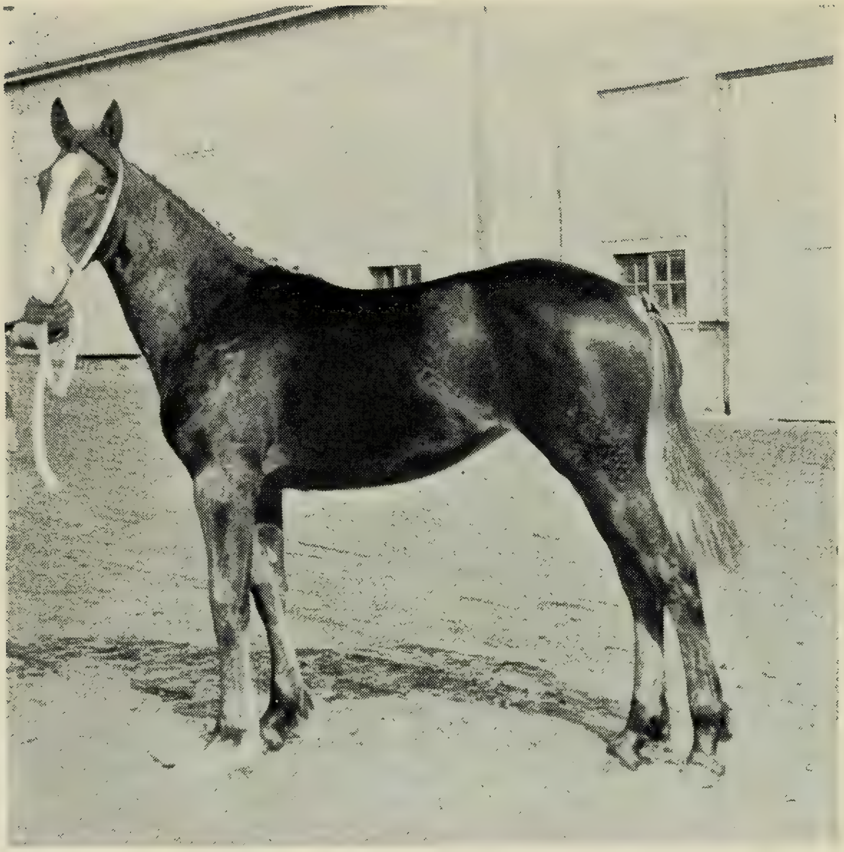
Position of Hind Legs—Viewed from the side, a perpendicular line from the point of the buttocks should run parallel with the back of the cannon bone and meet the ground just back of the heel.

Action:

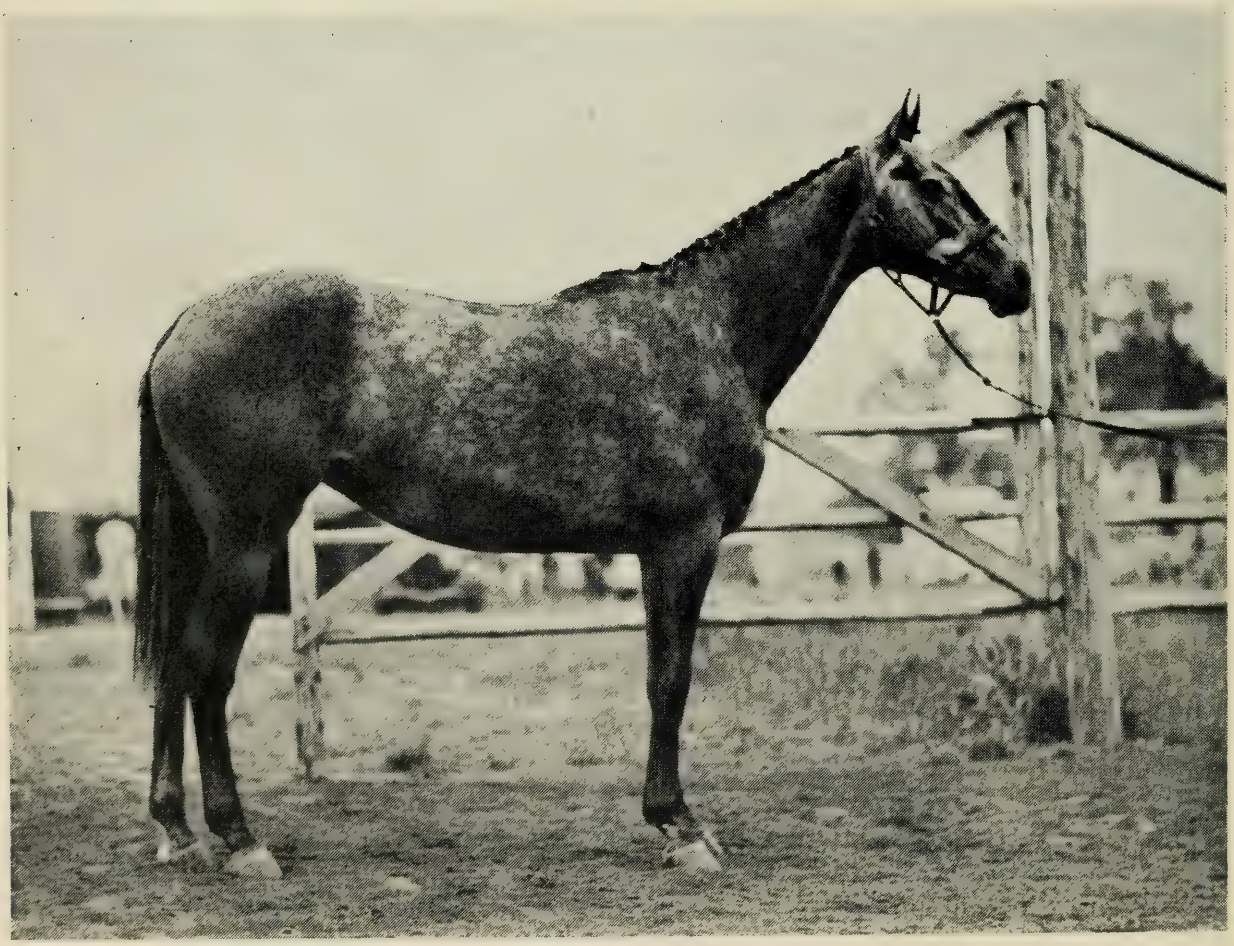
Walk—Easy, smooth and in line.

Trot—Free, springy, square, not extreme in knee fold.

Performance—Hunters are usually judged on conformation and performance. The percentage allotted for each varies with the class. It is not necessary here to deal with methods of scoring faults in jumping.



A half bred yearling filly. This filly appears a trifle long in the back.
Sire, Thoroughbred stallion. Dam, Clydesdale mare. Photo taken at eleven months.



A good type of middle weight Hunter. A prize winner in both Canada and the United States.

JUDGING SADDLE HORSES

In judging Saddle horses much stress is placed on the eye appeal. In other words beauty of conformation is one of the main items in determining the value of a Saddle horse.

There are a number of points to consider:

1. Conformation including quality and soundness. A more lofty carriage and higher action is desired than in a Hunter. He also differs from the Hunter in that he is not required to have the same fineness of withers and obliquity of shoulder.
2. Action—Must have at least three gaits, walk, trot and canter.
3. Manners are essential and may count as much as 50 percent. The horse must stanp quietly and back up without undue rein pressure.

JUDGING THE PALOMINOS

The Palominos are light horses of riding type. Palominos are usually judged on colour, conformation and performance. Colour is sometimes counted as 50 percent and for a full score body colour must be of pure gold. Mane and tail shall be white, ivory or silver.

THE CARRIAGE OR HEAVY HARNESS TYPE

Horses shown in this class are usually very largely if not all of Hackney breeding. The action is quite distinctive. The manner in which they move and the appearance they make while going are much more important than speed. The natural Hackney action is developed by training and the methods of shoeing. It is quite essential that the Hackney have a balanced action. Some Hackneys have extreme knee action but the hock action does not correspond.

The form is quite distinctive in this type. It is close and full made in comparison with the Hunter and Roadster types.

JUDGING CARRIAGE OR HEAVY HARNESS HORSES

(*Based on order of observation*)

The following is a suggested guide in connection with the judging of carriage horses:

General Appearance:

Height, Weight, Form, Quality and Temperament.

Height—In cases where height is specified the horse should be within the range of height.

Weight—This is variable.

Form—Close, full made, smoothly turned, symmetrical.

Quality—Bone clean, hard, fine yet indicating substance; tendons and joints sharply defined. Hide and hair fine, a general refinement, finish.

Temperament—Proud, bold, stylish, disposition good.

Head and Neck:

Head—Size and dimensions in proportion. Clear cut face line. Wide angle in lower jaw. Muzzle fine, nostrils large, lips thin, trim and even. Eyes, large, full, bright, clear.

Forehead—Broad and full.

Ears—Medium sized, fine, pointed, set fairly close together and carried alert.

Neck—Long, lofty, carried high. Throat latch well cut out and head well set on.

Fore Quarters:

Shoulders—Long, oblique and smooth.

Forearm—Medium length, muscular and carried well forward.

Knees—Straight, wide, deep and strongly supported.

Cannons—Medium length, broad, flat and tendons sharply defined.

Fetlocks—Wide tendons, well apart, straight and well supported.

Pasterns—Long, oblique (45°), smooth and strong.

Feet—Large, round, uniform, straight. Slope of wall parallel to slope of the pastern. Heels wide, full; horn dense, smooth and dark coloured.

Legs—Viewed from in front, a perpendicular line dropped from the point of the shoulder should divide the leg and foot into lateral halves.

Body:

Withers—Well set up, narrow, extending well back.

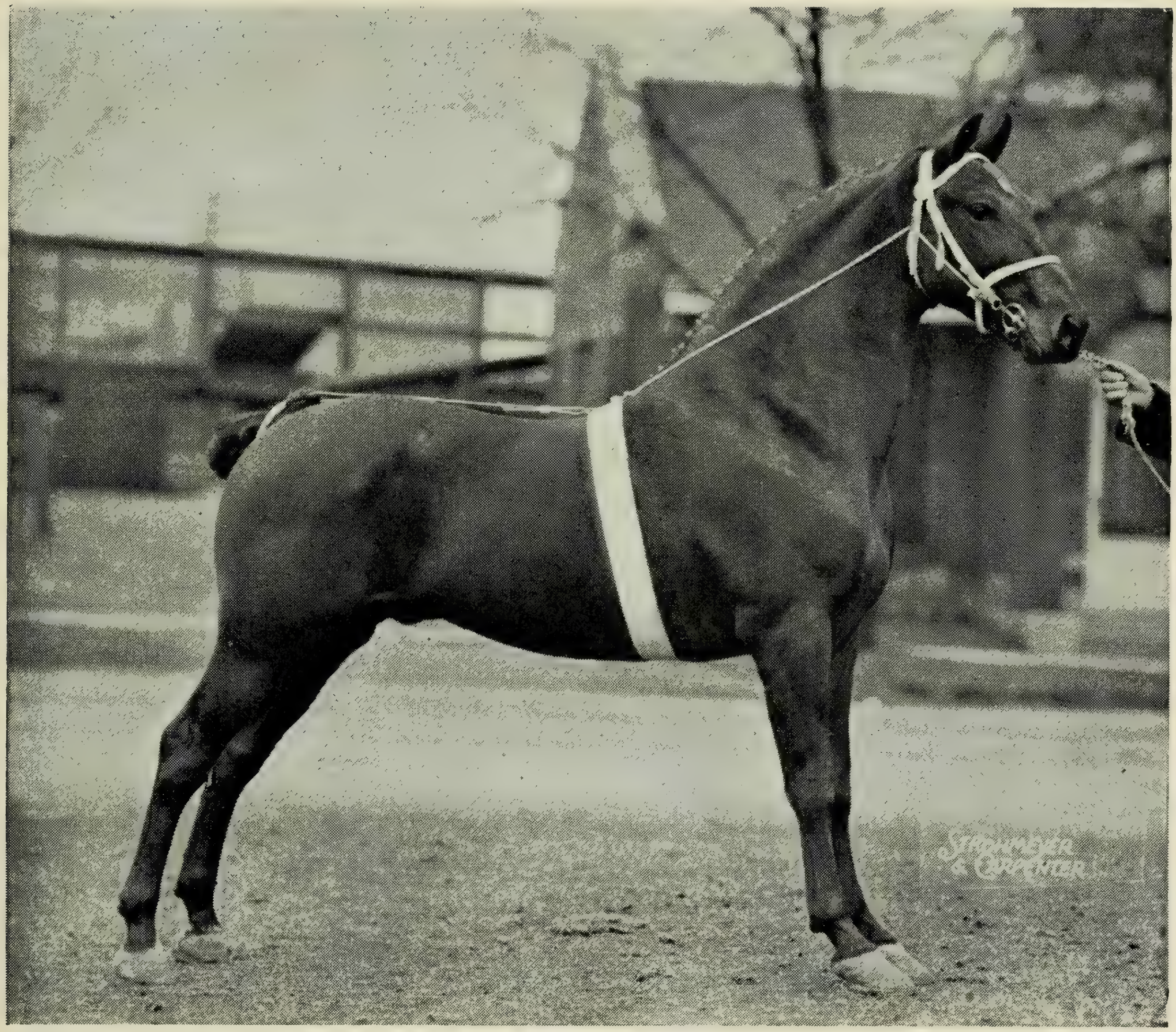
Chest—Wide.

Ribs—Well sprung, long and close.

Back—Short, straight.

Loin—Broad and strongly coupled.

Flank—Deep and full.



Hackney stallion.

Hind Quarters:

Hips—Broad, round and smooth.

Croup—Long, round and smooth, tail set high and well carried.

Thighs—Full and muscular; stifles broad, full and muscular.

Hocks—Straight, wide, deep, clean cut and smooth.

Cannons—Medium length, broad, flat; tendons sharply defined.

Hind Legs:

Wide tendons well back, straight and well supported.

Pasterns long, oblique (about 45°). Foot large and round.

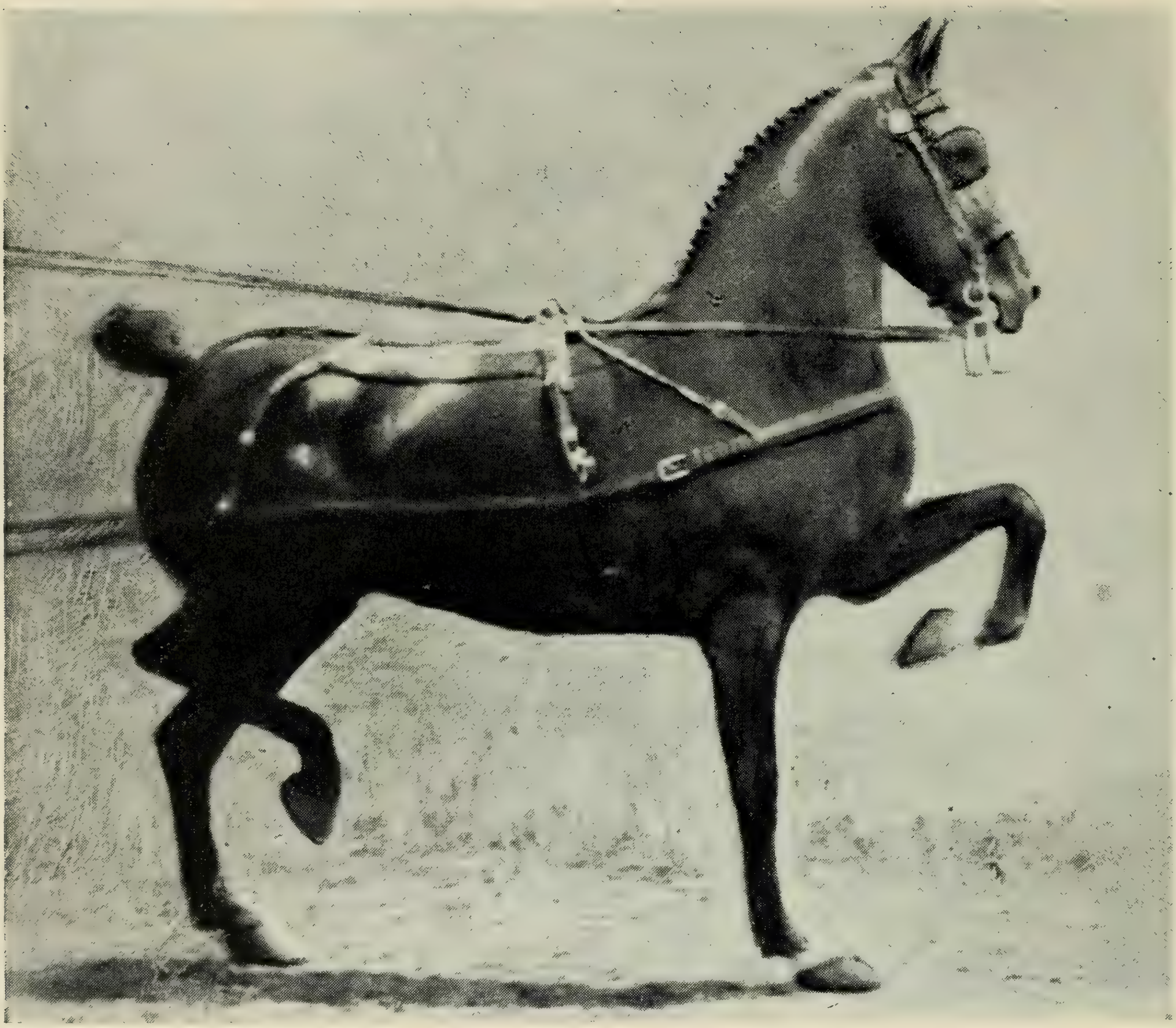
Viewed from the side, in the natural position, a perpendicular line dropped from the point of the buttock should touch the back of the hock and meet the ground some little distance back of the heel.

In the characteristic "Hackney" poise often seen in the show ring, this rule would not be applicable.

Way of Going:

Walk—Straight, snappy, springy, proud and stylish.

Trot—In line, bold, flashy, extreme flexion of knees and hocks, balanced, regular.



Hackney form and action.

THE LIGHT HARNESS OR ROADSTER

This type is used for harness racing and also for show purposes in the Roadster classes at the fairs. Speed, style, conformation and manners are the main essentials of a good show road horse.

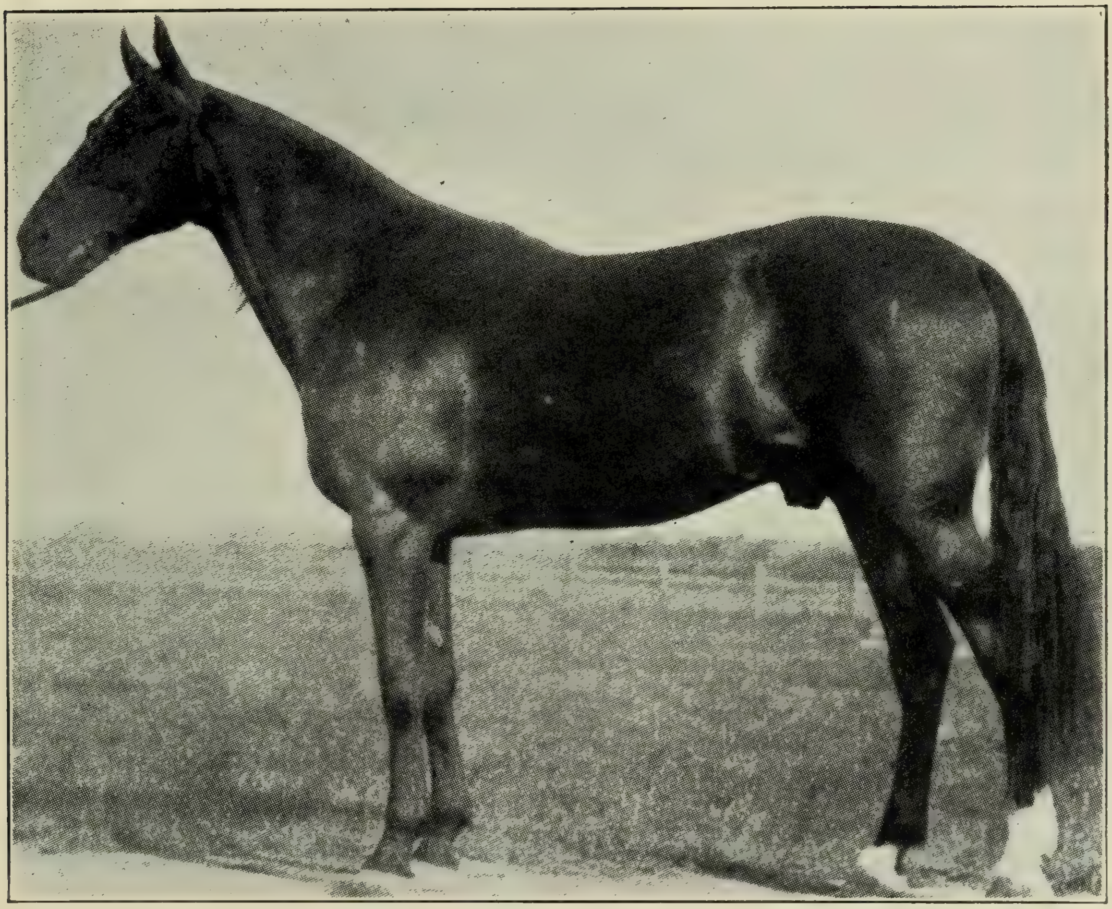
In contrast with the heavy harness or carriage horse he must be angular, not having the form rounded by bulky muscles and carrying no excess weight in fat. He must be deep to ensure ample heart and lung and digestive capacity which it is not possible to secure by width.

Quality, denoted by the texture of the skin, is associated with durability.

The temperament should be nervous in order to have the speed and courage to perform.

Way of Going—Road horses should trot. The term light harness has been used because road horses are usually driven with a comparatively light harness in contrast with the heavier harness of the carriage type.

The way of going, along with the style of the animal, in harness or on the line is most important, for without speed, action and style a Standard Bred horse does not count for very much.



A Standard Bred stallion showing the light harness type.

JUDGING THE ROADSTER OR LIGHT HARNESS HORSE

(*Based on order of observation*)

The following is a suggested guide:

General Appearance:

Height, weight, form.

Form—Rangy, deep, lithe, and angular.

Quality—Bone clean, dense, fine yet indicating substance; tendons and joints sharply defined; hide and hair fine; general refinement.

Temperament—Nervous, active, disposition good and intelligent.

Head and Neck:

Head—Size and dimensions in proportion, clear cut features, straight face line, wide angle in lower jaw.

Muzzle—Fine, lips thin, trim and even.

Eyes—Large, full, bright and clear.

Forehead—Broad and full.

Ears—Medium sized, fine, pointed, set fairly close and carried alert.

Neck—Long, lean, crest well defined, extended carriage, clean cut in the throat latch with the head well set on.

Fore Quarters:

Shoulders—Long, oblique and smooth.

Forearm—Fair length, muscular, carried well forward.

Cannons—Short, broad; tendons sharply defined.

Fetlocks—Wide, tendons well back, straight and well supported.

Pasterns—Long and oblique (45°), smooth and strong.

Feet—Large, round, uniform, straight. Slope of the wall parallel to the slope of the pastern. Heels wide and full. Horn dense, smooth and of a dark colour.

Legs—Viewed from in front, a perpendicular line dropped from the point of the shoulder should divide the leg and foot into lateral halves.

Body:

Withers—Well set up, narrow and extending well back.

Chest—Medium width, deep.

Ribs—Well sprung, long and close.

Back—Short, straight, strong, broad.

Loin—Short, broad, strongly coupled.

Flank—Deep and full.

Hind Quarters:

Hips—Round and smooth.

Croup—Long and smooth. Tail set high and well carried.

Thighs—Full and muscular. Stifles broad, full and muscular.

Gaskins—Broad and muscular.

Hocks—Straight, wide, deep, clean cut.

Cannons—Medium length, broad, flat; tendons sharply defined. Pasterns long and oblique (about 45°), smooth and strong.

Feet—Large, round, uniform; horn dense, smooth, dark coloured.

Hind Legs—Viewed from the side, a perpendicular line from the point of the buttock should touch the point of the hock and meet the ground some little distance back of the heel.

Way of Going:

Walk—Long, free stride.

Trot—Long, rapid, straight.

JUDGING HORSES IN BREEDING CLASSES

The preceding discussion has dealt with the various types of the horse in use for pleasure or work. Some further details should be observed in making awards in breeding classes.

Stallions:

If like tends to beget like the stallion should have masculinity, breed type and a conformation as nearly ideal as possible (with no outstanding faults). The stallion should have the determined expression, the hard features, the high crest and full neck that are evidences of masculinity. With these there should be the active, vigourous temperament. One should bear in mind that a stallion during the breeding season may not carry the depth of middle that he would have at other seasons of the year.

Mare Classes:

In addition to the lighter head, neck and forequarter which is the proper type of the sex, the mare should differ from the stallion in the roominess of the barrel (middle). The ribs should be deeper and the body less compact and with much more length of loin than in the case of the stallions.

Colts and Fillies:

These are probably the hardest classes to judge. Observation has proved many times that it is the growthy colt or filly with ideal limbs and apparently lacking body that is likely to prove the superior animal when mature. The smooth bodied colt or filly that is not constructed correctly may not develop so well. For example, in a class of yearling or two-year-old draft fillies, they should look their age and not show too much evidence of maturity. There should be evidence that they are growing and not becoming fat.

Defects in Action:

Good action has certain definite characteristics. Essential for good action whether a horse be a draft, a carriage, a hunter, or a road horse are feet and legs of the right conformation, combined with a correct balance. It is impossible for a horse to have true action if the legs are incorrectly set or if the feet are misshapen.

There are a number of defects or peculiarities in the way of going of horses. Some are more prevalent in one type than another.

Paddling—An outward deviation in the direction of the stride of the foreleg, the result of a toe narrow or a pigeon-toed standing position.

Winging—Exaggerated paddling, noticeable in high going horses.

Winding—A twisting of the striding leg around in front of the supporting leg in much the same manner as paddling. This is most commonly seen at the walk in wide fronted draft horses that toe out.

Rolling—Excessive lateral shoulder motion often seen in the wide fronted draft horses at the trot.

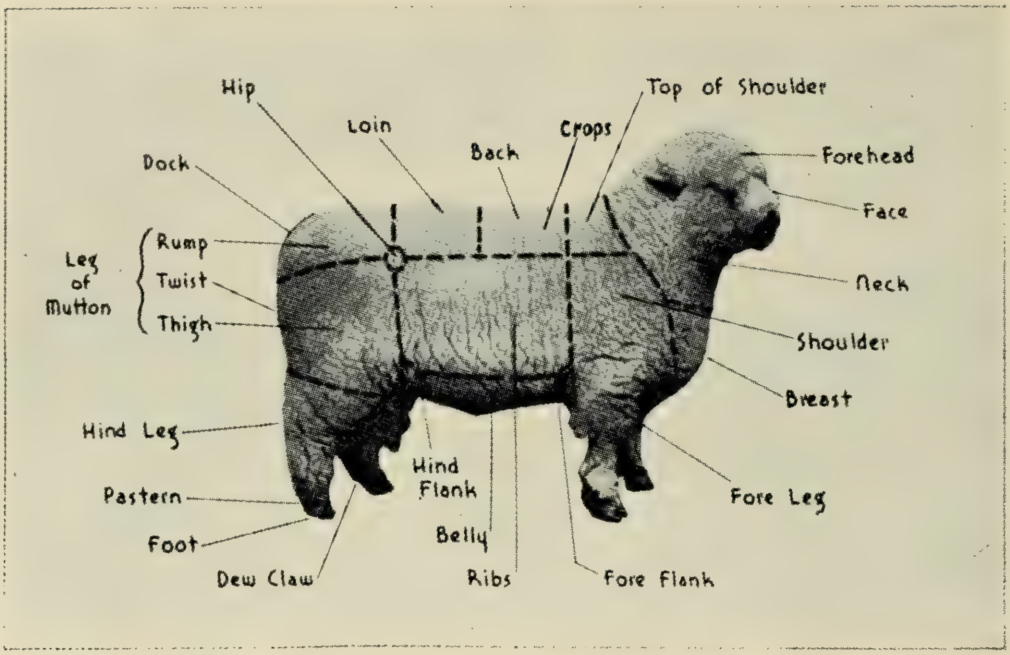
Forging—Striking the ends of the branches or the under surface of the front foot or shoe with the toe of the hind foot.

Interfering—Striking the supporting leg, usually at the fetlock, with the foot of the striding leg. It is more common in horses standing base narrow or toe-wide.

Trappy—A quick, high, but comparatively short stride.

Dwelling—A perceptible pause in the flight of the foot as though the stride has been completed before the foot has reached the ground. Most noticeable in high steppers.

In normal action the heels meet the ground very slightly in advance of the toe. In some horses the heel very distinctly contacts the ground much in advance of the toe. This is objectionable.



Points of a sheep

A typical market lamb

SHEEP

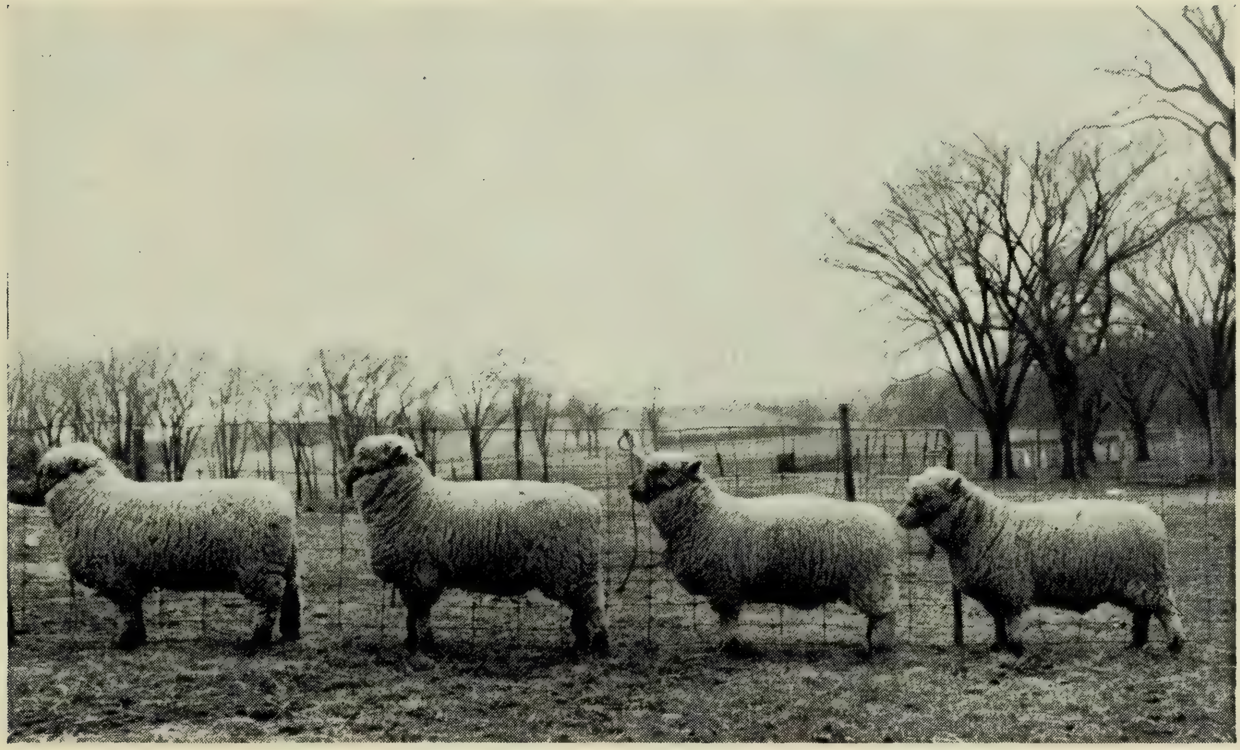
METHOD OF INSPECTION

In judging sheep it is desirable to stand well back from the class so that you may see all animals at the same time and compare them with each other.

A mutton type sheep or lamb should be built like a good beef type animal.

It should be deep, blocky and low set, rectangular in shape, and carry an even distribution of fleshing. When judging breeding classes, the width of head, width between the eyes, the shortness of neck, the width of the chest floor as well as the amount and quality of bone and the way the animal stands on its legs are also important.

Breed character in breeding classes should always be taken into consideration. The fleece is also a factor in judging breeding stock. Each breed has certain fleece characteristics and these should be studied along with general breed character when judging breeding stock.



Comparing the above four animals as a class of market lambs. Side view.

No. 1 Lamb: *Thick, blocky, low set, very rectangular in shape, short neck, well filled neck vein, strong, even top line carrying the meat out well to the dock and well developed in the leg.*

No. 2 Lamb: *Taller, more rangy lamb, while it shows a strong top line. The neck is a trifle long. It is not as well let down in the fore or rear flanks and the hind legs show a flatness and lack of filling.*

No. 3 Lamb: *A wasty type of lamb showing a lack of balance. While more low-set than No. 2, it is long in the neck, a trifle open on the shoulder and stands poorly on the hind legs. Because of the heavy middle, it would likely have a lower dressing percentage than the other three lambs.*

No. 4 Lamb: *A low-set, well balanced lamb, not quite as short in the neck as No. 1 but better balanced than either No. 2 or No. 3.*

JUDGING MARKET LAMBS

In judging a class of market lambs there are four important factors to consider:

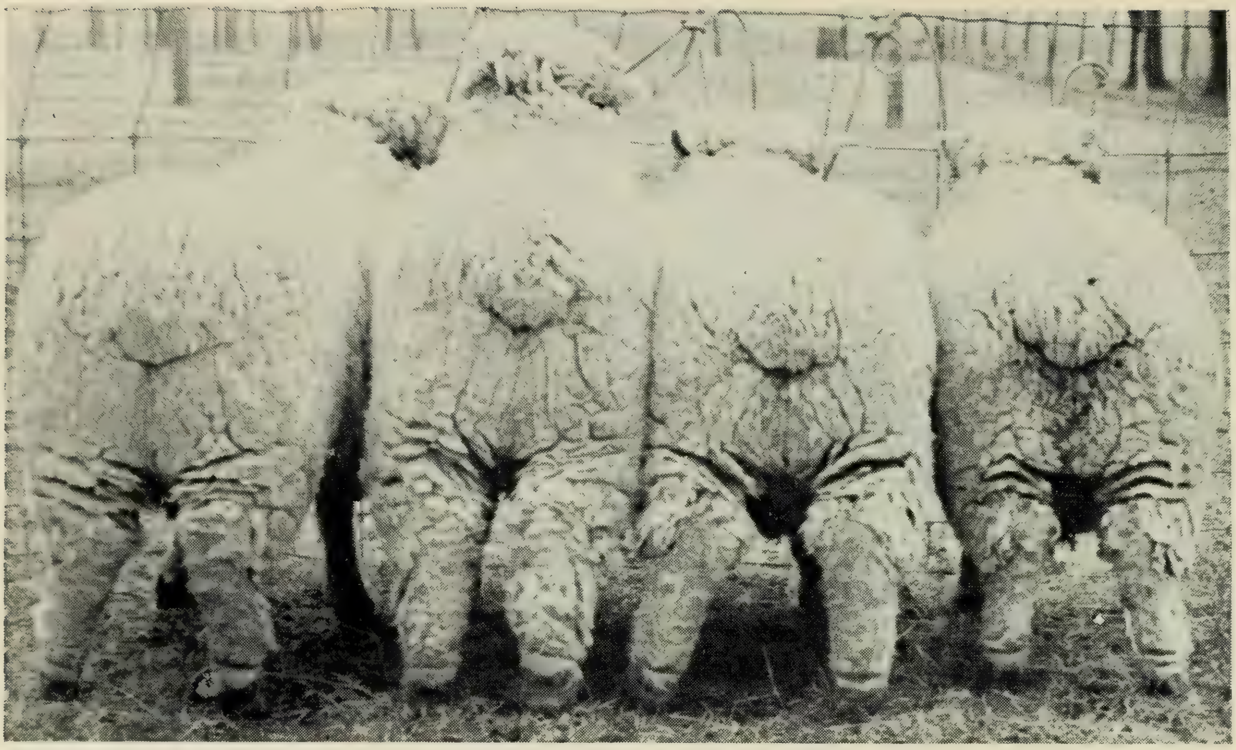
1. Weight. 2. Type. 3. Finish and Quality. 4. Dressing Percentage

1. The most desirable market weight is from 85 to 100 pounds. Lambs under 85 pounds are usually too light to yield the feeder a satisfactory profit while lambs over 100 pounds usually are over fat and a trifle wasty while the cuts are too large to sell to advantage to the average housewife.

2. As indicated above, a deep, low set blocky lamb as rectangular as possible with a short neck, well filled neck vein and a strong broad loin carrying the width out well to the tail-head is desired. A deep, well filled twist ending in a leg that is well filled both on the outside and inside with the meat carried well down to the hock makes the lamb more valuable from the butcher's viewpoint.

3. A market lamb must have finish to be considered profitable to both feeder, butcher and consumer. An even distribution of firm quality fleshing is desired. In handling you note the fleshing on the shoulder points, on the ribs and the most important part, the loin, and the dock. The quality of the fleshing is also as important as the amount. A firm even fleshing is preferable to a soft flabby covering that usually is unevenly placed.

4. Finished sheep that are trim in the middle and light in the pelt dress high. A lower dressing percentage because of the heavy fleece is not objectionable as the fleece has a high market value. Wasty lambs do not yield a high percentage of carcass.



The rear view gives the judge an opportunity to compare the buttocks and rear legs, the most expensive part of the carcass.

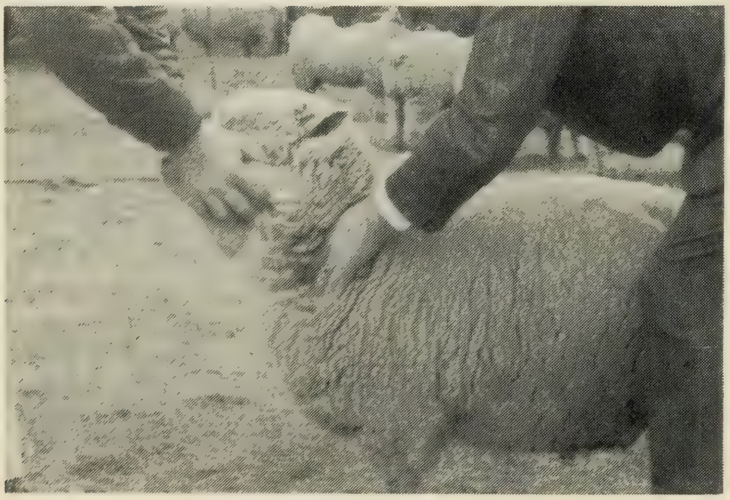
No. 1 Lamb: ***Very broad, carries out well to the dock, thick through the buttocks, well let down in twist and carries meat well down to hock.***

No. 2 Lamb: ***Narrow, well enough let down in twist but rather naked or flat on outside of legs and lacks general thickness and filling on outside of leg.***

No. 3 Lamb: ***Thick, well filled leg, not as well let down in twist as No. 1.***

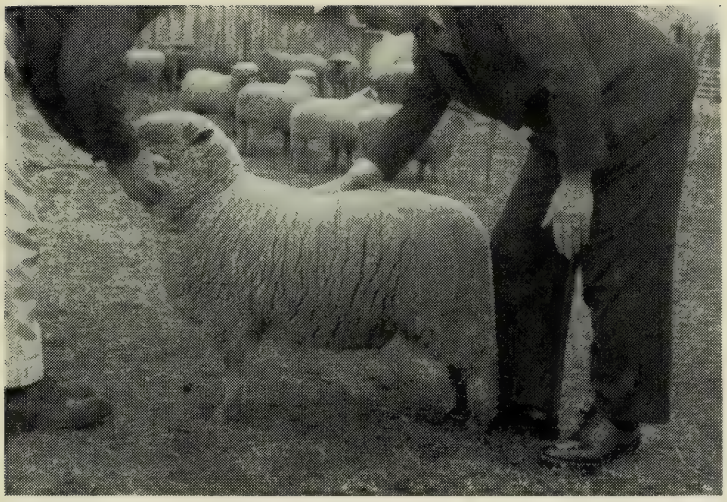
No. 4 Lamb: ***Smooth, even and nicely balanced rear quarters but not as thick through the thighs or as well let down in the twist as No. 1.***

After observing the animals carefully from a distance and comparing them on general type and conformation it is also desirable and necessary to handle each animal systematically to verify your findings or in other words—prove with your hands what you already have observed from a distance.



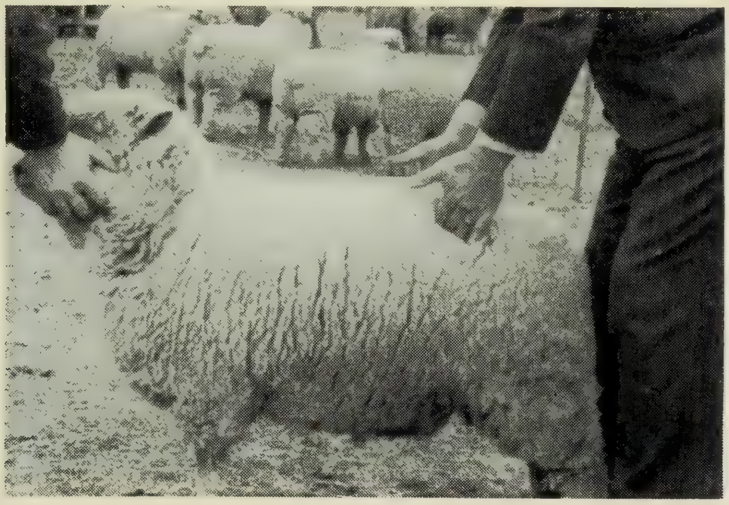
FIRST STEP

With fingers extended but close together grasp the lamb around the top of the neck. This will give you an idea of the size and length of neck and also the amount of flesh in the neck vein, the junction of the neck and shoulder.



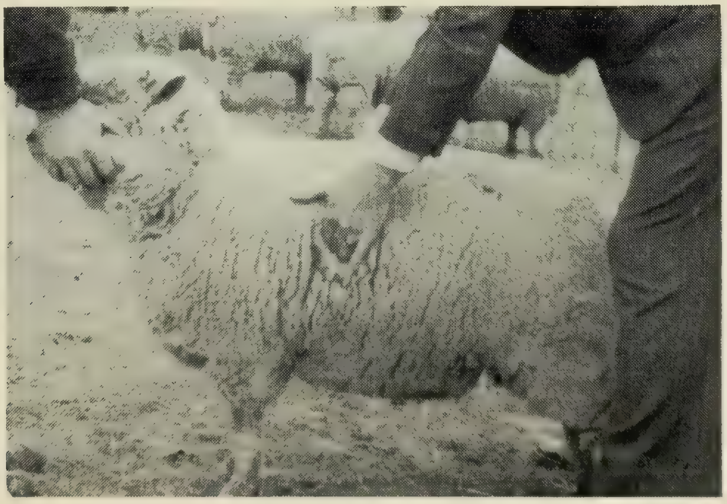
SECOND STEP

The smoothness over the top of the shoulder points and the filling in the crops is examined in the above manner.



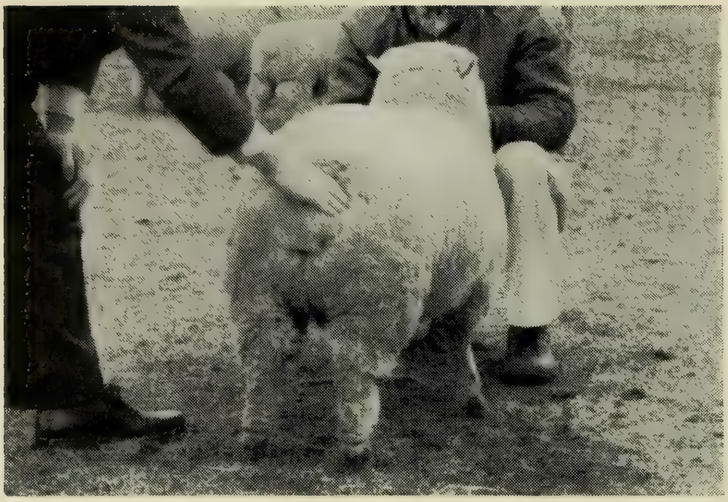
THIRD STEP

The width and depth of loin are examined in the above manner. As the most expensive cuts come from this region it is desirable to have a strong broad loin showing depth and a reasonable amount of firm fleshing.



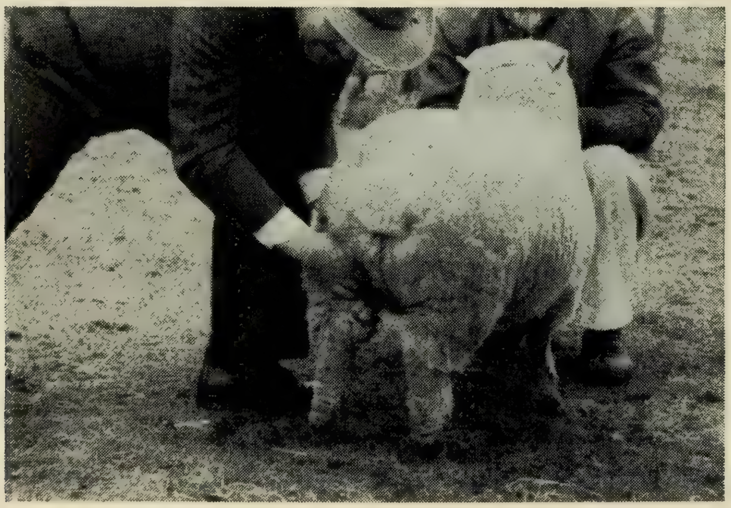
FOURTH STEP

The amount and quality of fleshing on the ribs can be determined by pressing firmly with the finger tips as indicated above. Again an even covering of firm fleshing is desired.



FIFTH STEP

The filling at the dock and the amount of fleshing are determined by handling just above the dock as indicated above.



SIXTH STEP

The size of the leg and the amount of filling on both inside and outside can be estimated by grasping the leg firmly as close to the body as possible. It is necessary to use both hands pressing firmly if the comparison of this very important and expensive cut is to be estimated correctly.

PLACING OF CLASS

The final decision on the placing of the class is made after each animal has been handled in the approved manner, and the amount, distribution and quality of fleshing considered in conjunction with their general type as observed from side and rear view.

Numbering the animals from the left in the rear, they would be placed 1—4—3—2 for the following reasons:

Placing the class of market lambs 1—4—3—2.

Placing 1 over 4:

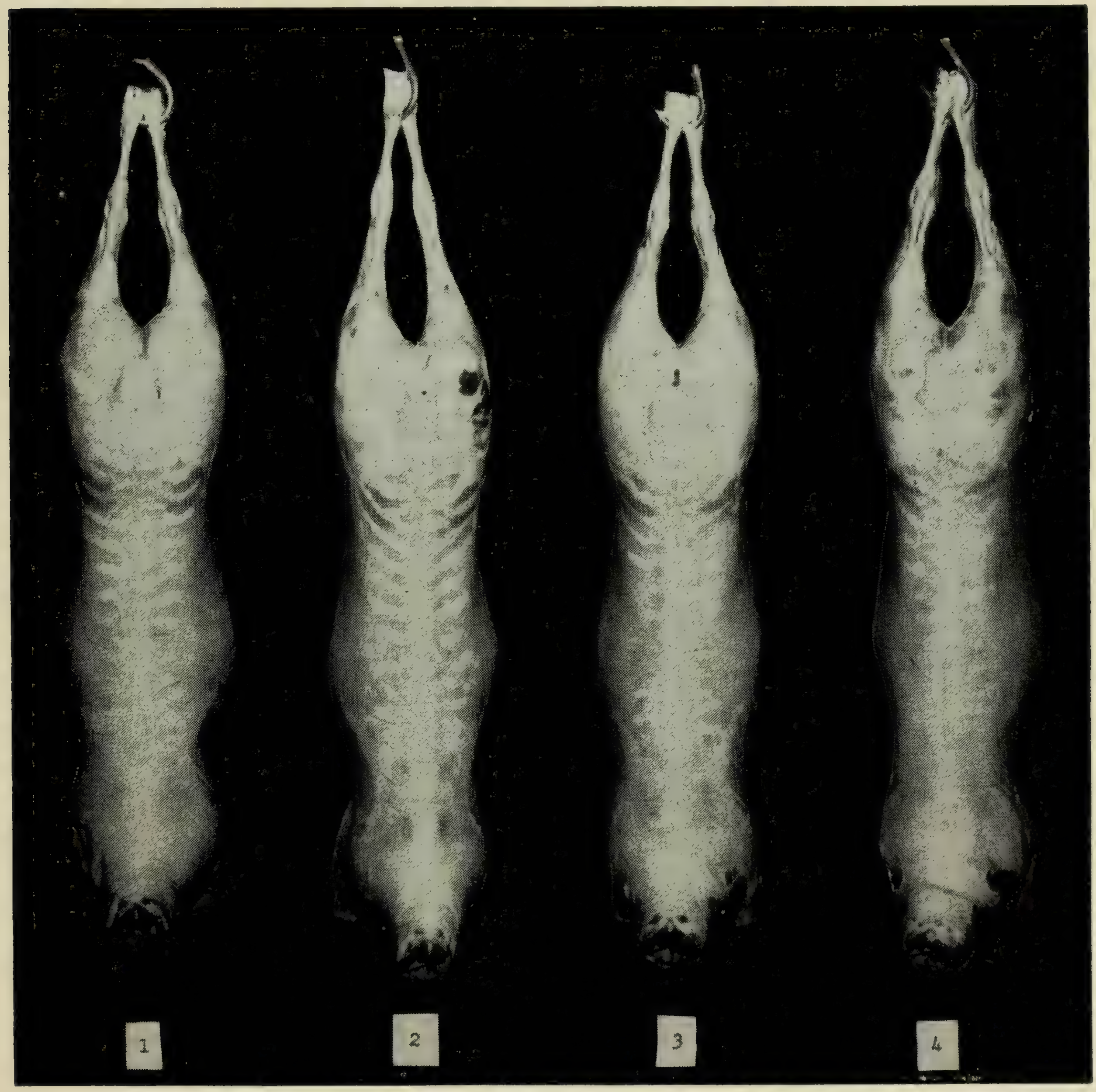
A thicker, blockier, lower-set lamb, with a shorter neck and with slightly more filling in the neck vein. Both lambs are well filled in the legs, but No. 1 is slightly better let down in the twist. No. 1 also is trimmer in the underline and should give a slightly higher dressing percentage.

4 over 3:

A very close placing. No. 4 shows more balance than No. 3 and is slightly shorter in the neck and smoother on top of the shoulder. Very little to choose in the legs, and No. 3 carries equally as much finish down the top.

3 over 2:

An easier placing. While not as trim in the underline, No. 3 is lower set, has more thickness, has a fuller leg, and is better let down in the twist. In addition, No. 2 shows the least finish in the class.



THE SAME CLASS ON THE RAIL

The above picture shows the carcasses of the lambs in the class and is the real "proof of the pudding".

No. 1—Is an easy winner. Showing the best balanced carcass with the shortest neck, the most even spread, the broadest loin, with an even covering of fleshing and the largest leg.

No. 2—An easy loser. Showing the least desirable carcass and definitely lacking balance. The longest neck, the poorest filling in the crops, the narrowest loin and the thinnest, poorest filled leg.

Nos. 3 and 4—A very close pair.

No. 3 is slightly better filled in the crops and has a more even distribution of fleshing around the dock and on the leg.

No. 4—Slightly broader loin, equally as full in leg, about the same amount of fleshing.

A careful examination of the four carcasses proves that the live judging is fairly accurate, providing the contestant is able to recognize and properly evaluate fleshing.

No. 1—The outstanding winner on all scores—general appearance, handling qualities and carcass.

No. 2—The easy loser. The least desirable type, lacking depth and width, and easily the poorest carcass. Especially note the long neck and lack of filling in the leg.

Nos. 3 and 4—A very close pair and may be placed either way. On general type and conformation, No. 4 excels No. 3. In handling, No. 3 shows a slightly superior quality of fleshing and presents a slightly better balanced carcass with a more even distribution of fleshing.

JUDGING BREEDING CLASSES

In judging breeding classes one must consider the following points:

1. Mutton Type
2. Breed Type and Character
3. Growth and Development
4. Quality and Quantity of Bone
5. Quantity and Quality of Fleece

1. *Mutton Type:*

As approximately 70% of the income from the sheep flock is derived from the sale of lamb carcasses, mutton type must always be considered first.

2. *Breed Type and Character:*

Each breed has certain definite characteristics and these should always be considered. Space does not permit a full discussion on this important point as there is a great variation between the breeds. A careful study of the pictures will give you a general idea of the main points. However to become really familiar with the breeds you must work with and judge the live animals.

3. *Growth and Development:*

As the rate of growth is closely linked with the profit to be made from the sale of market lambs it is desirable to consider growth and development carefully when judging breeding stock. A head showing good width at the poll and between the eyes along with a strong muzzle generally indicates strength and when coupled with a broad chest and general width throughout are really important factors. Poorly developed and undersized breeding stock should be severely penalized in the judging ring regardless of their breed character or quality of fleece as they cannot be expected to produce fast maturing top quality market lambs.

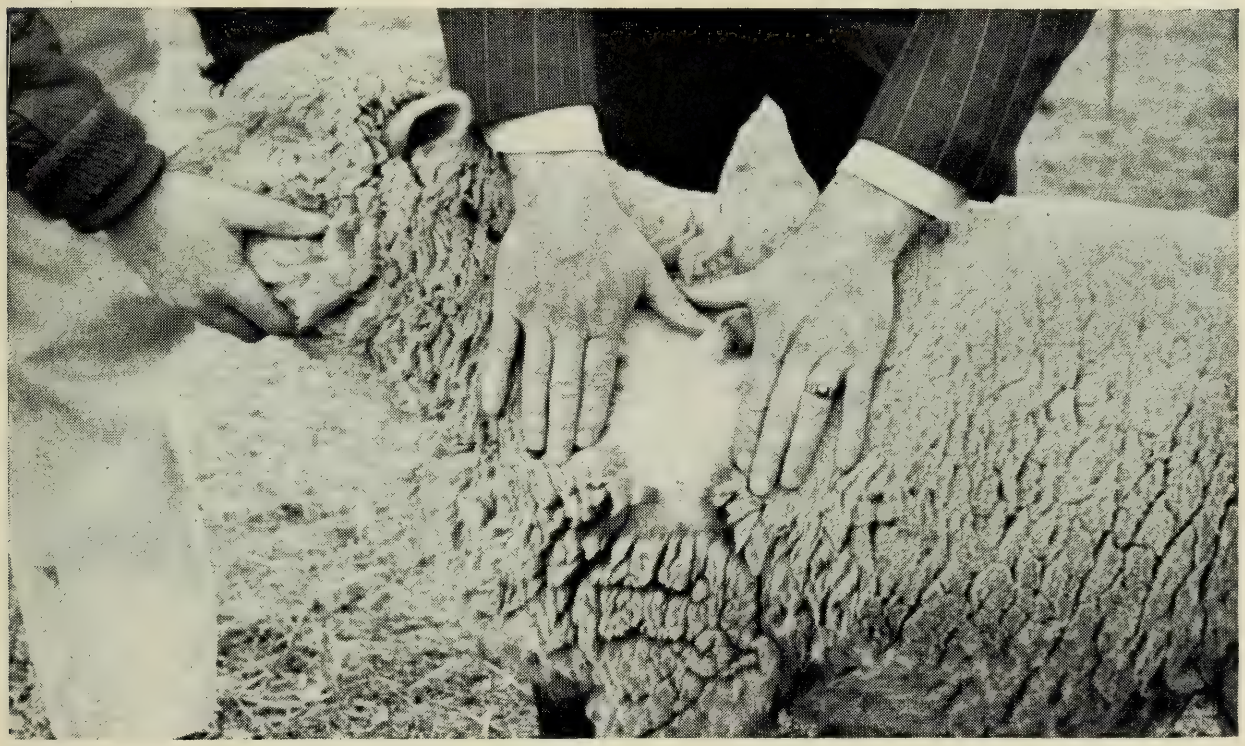
4. ***Quality and Quantity of Bone:***

A satisfactory breeding sheep of either sex should have ample bone yet without undue coarseness. Generally an animal that has plenty of bone grows and develops more quickly than one that is inclined to be too fine in the bone. However, with this strength of bone it is desirable to have as much quality as possible. Lack of quality is usually indicated by a coarseness about the joints.

A lack of bone is often indicated by a weakness in the pasterns. Weak pasterns should always be avoided especially in rams.

5. ***Quantity and Quality of Fleece:***

All breeding animals should reach and preferably exceed the minimum requirements in pounds of wool for their own particular breed. Quality is indicated by density and length. Quality is more difficult to determine and the beginner may have trouble in noticing the actual difference in quality.



INSPECTION OF FLEECE

EXAMINING THE FLEECE

To examine the fleece properly it should be opened in straight parts about half way down the side in as good light as possible and at three points:

1. *Shoulder*—The finest quality wool is usually found on this section.

2. *Body*—The wool here is about average and is a fair indication of the general quality.

3. *Rump*—The coarsest wool is always found in this region and by comparing the quality of the wool found in the three sections one is able to evaluate the uniformity.

Note—After examining the wool gently press the opening together so as not to give other contestants an opportunity of seeing the fleece to advantage.

The three main features to consider in examining the fleece are quantity, quality and condition.

Quantity of Fleece—Quantity of fleece is determined by the length and density and the uniformity of these two characteristics. Length of staple is of much importance. The variation in the length is principally due to breed although there is also much variation in length of the different parts of the same fleece.

Density of fleece means the closeness and compactness of the fibres or the number of fibres per square inch on the body of the sheep. The density of a fleece may be determined in a comparative way by noting to what extent all the wool which one can grasp fills the hand. Density is associated with weight. Moreover, if the fleece is not dense you are justified in looking for weak spots in the fibre although you may not always find them.

Quality—Quality is determined by the fineness of fibre, soundness, closeness of crimp, softness of fibre, colour and freedom from black fibre. The short wools are usually the finest quality wools while the long staple wools are coarser. This point should be taken into consideration when judging sheep of different breeds. Fineness refers to diameter of fibre.

One of the worst faults in wool is the presence of kemp, which is short, thick, opaque fibre, usually ivory white in colour. It occurs most commonly among the breech wool although it may be found in any part of the fleece. It varies greatly in structure from true wool and like black fibre will not take dye.

Crimp or waviness varies with the breeds. The most important point in regard to crimp is that it should be regular. Regularity of crimp is an indication of soundness of fibre. The finer the wool the finer the crimp. In opening a fleece for examination the crimp should always be noted for from it an estimate can be made both as to the soundness and fineness of the fibre.

The softness of the fleece can be readily determined by pressing it with the hand. This characteristic depends largely upon the breed and grade of wool.

Condition—The condition of a fleece is determined by the lustre, the amount and character of the grease or yolk, and the freedom from foreign material. The most common foreign materials are burs, chaff and dirt. Brightness depends to a large extent on freedom from dirt.

Lustre which is highly valued for the brightness it gives in light coloured dyed goods is due to the scale covering of the wool fibre. These scales overlap one another similar to fish scales and when the wool is in a healthy condition give somewhat of a sheen to wool when light shines upon it. Lustre is more obvious in the coarser wools owing to the larger scales presenting a greater surface for reflection of light. A fleece that is in poor condition will not have this lustre. Instead of the scales overlapping one another they will stand out more or less at right angles to the wool fibre and are contributing factors to the condition which is commonly known as cotting.

Yolk is the grease or oil that is naturally secreted by the skin and which passes up through the cells forming the core of the fibre. The yolk should be evenly distributed from the base of the fibre to the top and a shortage of yolk causes a harsh feeling fleece. A plentiful supply of yolk tends, on the other hand, to keep the wool in a sound, healthy condition and helps to turn rain out of the fleece.

The colour and covering of the wool over the head as is demanded by the breed of which the sheep is a representative, the region of the horn pits and back over the ears, the extension of the wool on the legs and the covering on the under surface of the body should also be observed.

SUGGESTED SCORE CARD

MUTTON TYPE SHEEP

Scale of Points:

GENERAL APPEARANCE—40 points

1. *Size*—Score according to age and breed.
2. *Form or Type*—Deep, wide, low-set; uniform in width and depth; symmetrical.
3. *Condition*—Even covering of firm fleshing, not excessively fat. Skin pink, not dark, blue or spotted.
4. *Quality*—Clean hard bone; refined features about head and ears; hair fine. In the case of a ram, refinement should not be given preference over masculinity and evidence of ruggedness.

HEAD AND NECK—4 points

5. *Head*—Broad and fairly short; feminine, refined features; eyes large and clear; mouth and nostrils large; ears not coarse. (In ram the head should be strong and masculine).
6. *Neck*—Short, well carried; clean at the throat; shoulder vein full (the neck of the ram should be especially thick and strong).

FORE QUARTERS—7 points

7. *Shoulders*—Compact and smooth; well covered with flesh joined smoothly to neck and body.
8. *Brisket*—Extended well forward; broad deep and full.
9. *Forelegs*—Short, wide apart, straight; pasterns strong, feet sound; bone clean.

BODY—26 points

10. *Chest* or *Heart Girth*—Deep, wide, full.
11. *Back*—Straight, strong, broad, deep, even covering of firm flesh.
12. *Loin*—Broad, strong; deep, even covering of firm flesh.
13. *Middle*—Roomy; ribs well sprung and deep, flanks low and full.

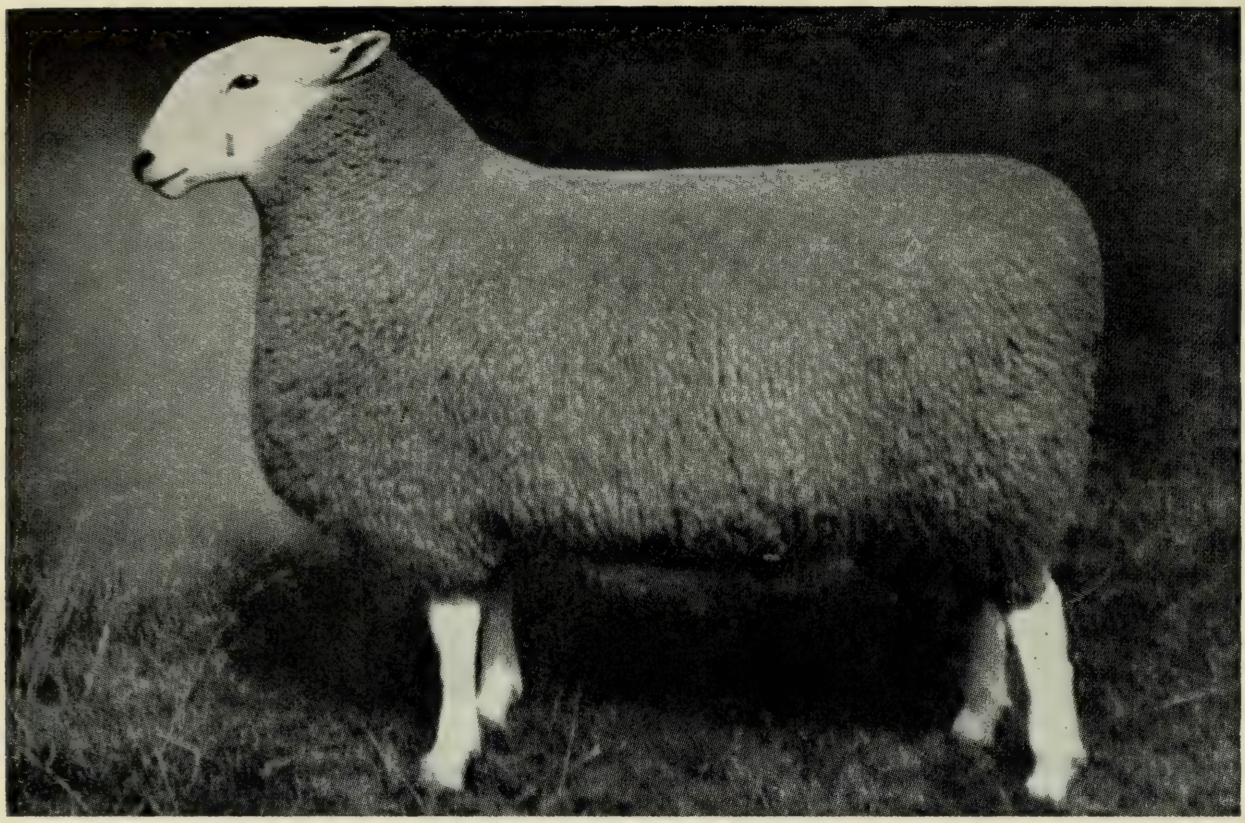
HIND QUARTERS—13 points

14. *Rump*—Long, level, wide, square at the dock, even, firm flesh; hips well covered.
15. *Leg of Mutton*—Thighs deep, thick and firm.
16. *Twist*—Deep, full, firm.
17. *Hind Legs*—Short, set wide apart, straight, hocks and pasterns strong; feet sound; bone clean.

FLEECE—10 points

18. *Fleece*—Long, dense (according to breed) uniform in length and fineness and in quality, free from dark fibres, sound, bright, clean, soft and sufficient yolk.

The following descriptions of the different breeds of sheep as bred in Ontario, which descriptions have been taken from the Shepherds' Hand-Book, are submitted for the benefit of those who are not familiar with the different breeds and the characteristics of same. The breeds are not necessarily listed in order of popularity within the Province.



BORDER LEICESTER

DESCRIPTION

Head—Carried rather boldly, erect and stately; moderately fine, tapering nicely to the nostrils; rather long and free from any growth of wool; covered with short white hair; black spots not favoured.

Face—Clear white; rather long and somewhat convex, giving a slight Roman effect, more noticeable in the rams.

Nostrils—Dark, wide and expanded; nose dark, mottled nose objectionable.

Eyes—Bright, clear and bold.

Ears—Neither too thin nor too fleshy; moderately long; carried erect and alert; covered with short white hair; black spots may appear on ears but are not favoured.

Weight—Rams 200 to 325 pounds; ewes 175 to 275 pounds.

Collar—Full from breast and shoulders, tapering gradually to junction of head and neck; no slackness where neck and shoulder join; neck vein well developed.

Shoulders—Broad, smooth and even, without depression either towards neck or back.

Breast—Broad and well developed, good width between fore legs. Girth and chest full and deep; brisket well forward.

Fore Flank—Quite full, leaving no depression behind the shoulder.

Back and *Loin*—Very broad; ribs deep and well arched, giving the back a wide, flat appearance; deep fleshed and smooth.

Belly—Level, covered with wool, and well let down at rear flank.

Quarters—Long and full, carrying the flesh well down to the hocks.

Hock—Straight and clean.

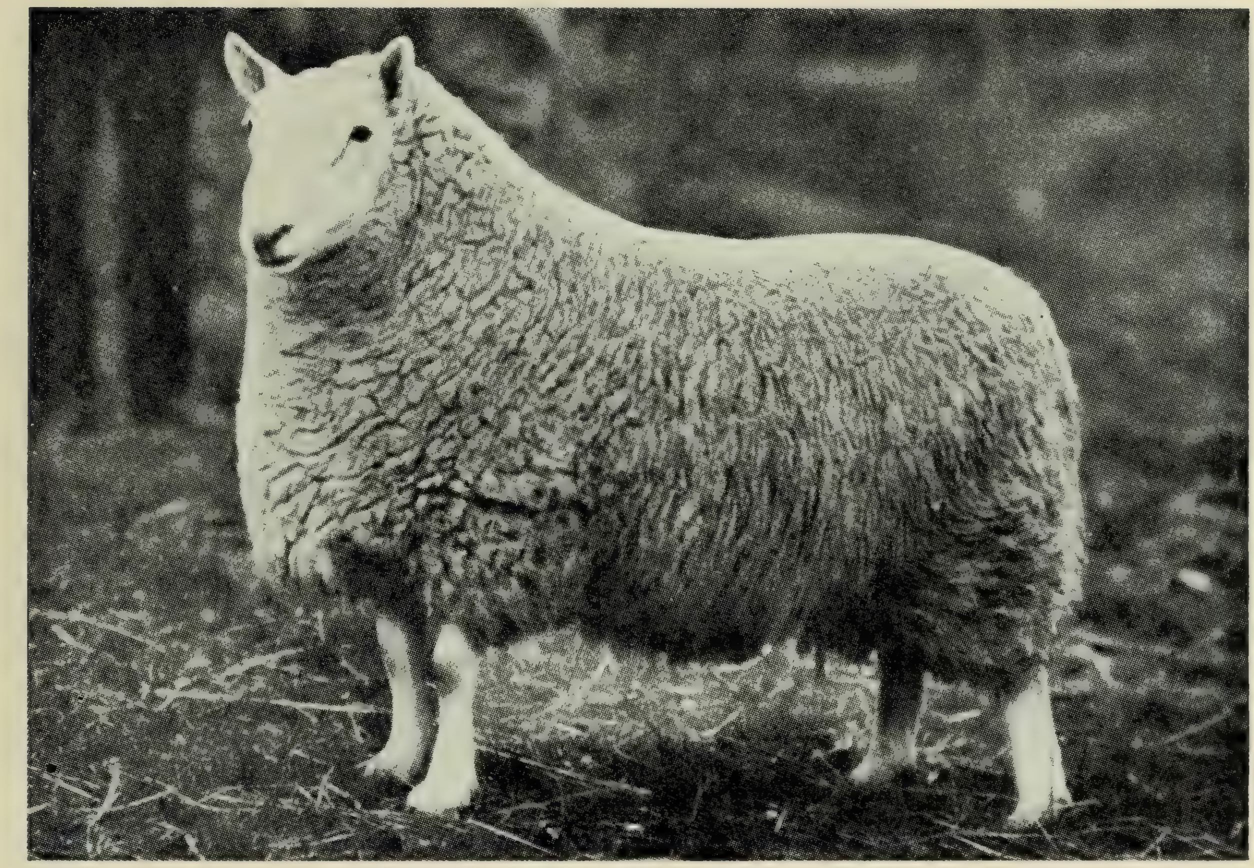
Twist—Low, wide and full.

Legs—Must be squarely set under the body, strong, with clean flat bone, covered with white hair, and free from wool; brown spots objectionable.

Skin—Pink and clear; free from spots on the body.

Fleece—The whole body excepting the head and legs should be covered with a glossy wool of good fibre, hanging in dense spirals which carry their "crimp" or wave right in to the skin. The fleece should consist of a mass of distinct curls all over the body, without the "parting" along the spine as in some other long-wooled breeds.

Style—So evenly and symmetrically balanced that the sheep is able to move and carry itself with a gaiety that is seldom equalled by other breeds.



CHEVIOT

DESCRIPTION

General Conformation and Quality—Deep through chest. Back wide and straight, with well sprung deep ribs; legs well placed and leg of mutton full and thick. Body well fleshed; skin pink with no blue or dark colouring; fleece compact, and medium fine; bone strong and fine; general appearance graceful, symmetrical, and active.

Size—In good flesh when fully matured, a twenty months old ram should weigh not less than 190 pounds, and a ewe not less than 130 pounds.

Head—Should be free from horns or scurs of any length. It should be medium length, and broad, with ample breadth between the eyes. Ears should be of medium length, and usually erect when at repose. Head covered with clean, white hairs extending from nostrils to back of poll. Ridge of head from between eyes to nostrils straight, or slightly arched in female, and more strongly arched or Roman in rams. Colour of tip of nose, black.

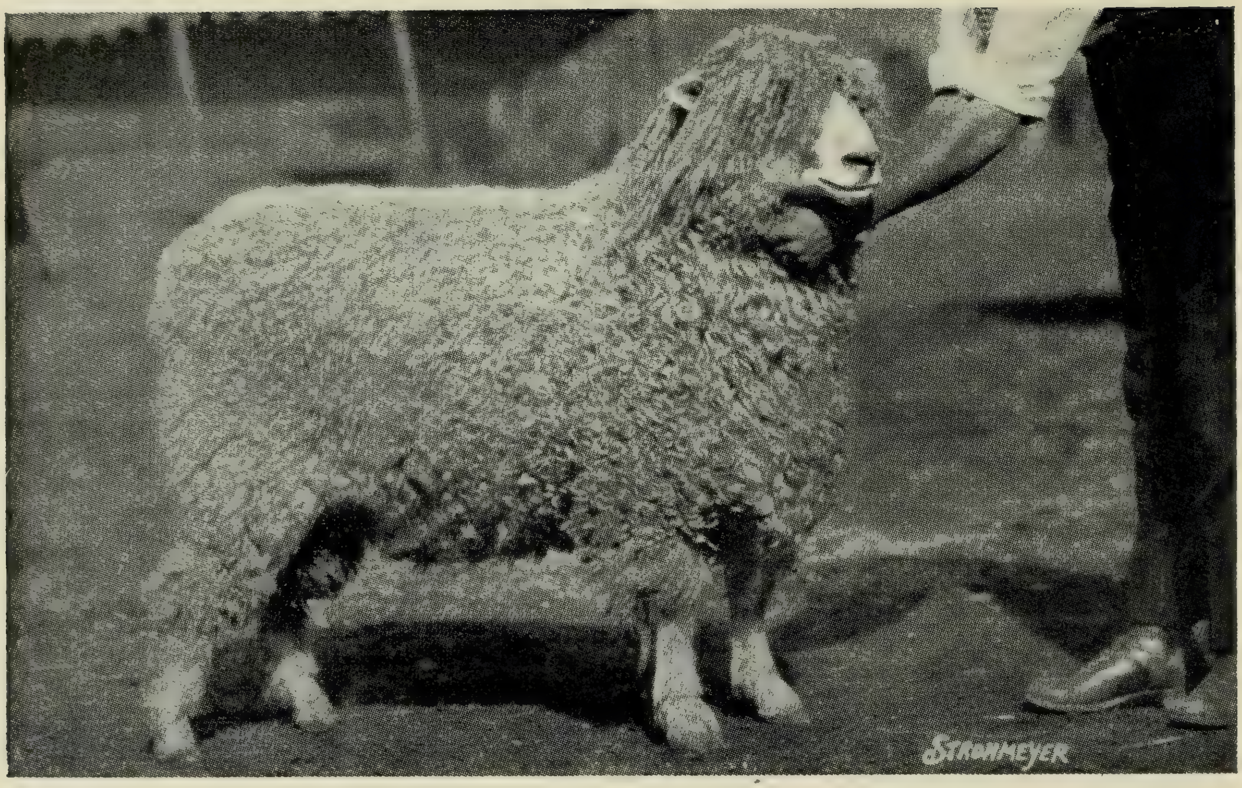
Body—Well proportioned, having notable depth, with thickness on top and at flanks. Loins very broad and thick; shoulders well back, and smoothly covered; crops full and well arched; rump long, broad and level.

Legs—Should be short, well set apart, and covered with clean white hair, with no wool below hocks and knees; hind legs flat and deep below hocks; pasterns strong, supporting the body well.

Feet—Symmetrical, squarely placed when in repose; hoofs black in colour.

Fleece—Should cover the body completely to back of poll and ears, and down to knees and hocks. Under part of the body well covered. In mature animals the wool should not be less than three inches long for annual growth, compact and of medium wool class. Rams should shear at least 12 pounds, and ewes 8 pounds, when in mature form.

Objections—Scurs on the head; flesh coloured skin about the nostrils; hair about the thighs, or kemp on the body; reddish or sandy hair on head or legs; lack of wool on under part of body.



COTSWOLD

DESCRIPTION

Head—Moderately fine, broad between the eyes and nostrils, but without a short, thick appearance, and well covered on crown with long lustrous wool.

Face—Either white or slightly mixed with grey.

Nostrils—Wide and expanded. Nose dark.

Eyes—Prominent, but mild looking.

Ears—Broad, long, moderately thin, and covered with short hair and wool.

Weight—Rams 240 to 340 pounds; ewes 180 to 265 pounds.

Collar—Full from breast and shoulders, tapering gradually all the way to where the neck and head join; neck should be fine and graceful in ewes, strong in rams.

Shoulders—Broad and full, and at the same time joined so gradually to the collar forward and chine backwards as not to leave the least hollow in either place.

Fore Legs—The flesh on the arm should come quite to the knee, leg upright with heavy bone, with wool to fetlock and may be mixed with grey hair.

Breast—Broad and well forward, keeping the legs wide apart. Girth and chest full and deep.

Fore Flank—Quite full, not showing hollow behind the shoulder.

Back and *Loin*—Broad, flat and straight, ribs well sprung and deep.

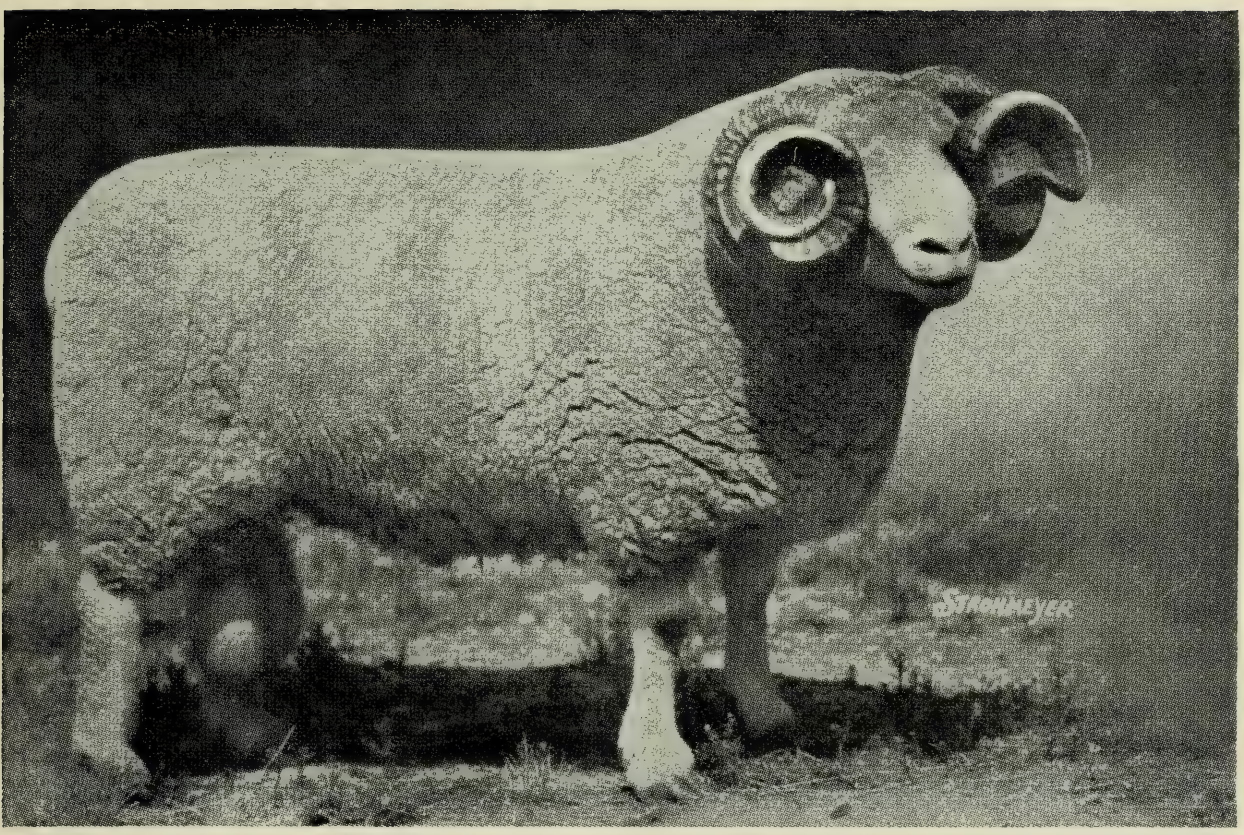
Belly—Straight on underline.

Quarters—Long, level and full, with mutton quite down to the hock.

Hock—Strong and straight.

Twist—Or junction inside of thighs, deep, wide and full, which with a broad breast will keep the legs open and upright.

Fleece—The whole body should be covered with dense, long, lustrous wool, having a bold, open curl.



DORSET HORN

STANDARD OF EXCELLENCE

Rams—Bold, masculine appearance and of robust character, head of great beauty, with strong and long horns growing from the head well apart, on the crown, in a straight line with each other, and coming downwards and forwards in graceful curves as close to the face as may be without necessitating cutting.

Ewes—Appearance bright with feminine characteristics. The horns much smaller and more delicate than in the ram.

General Characteristics:

Head—Broad, full and open at the nostrils, well covered with wool from brow to poll, face white with pink nose and lips.

Ears—Medium size and thin.

Teeth—Flat and chisel shaped.

Weight—Rams 210 to 285 pounds; ewes 160 to 225 pounds.

Neck—Short and round, well sprung from shoulders, with no depression at the collar, strong and muscular, especially in the ram.

Chest—Well forward, full and deep.

Shoulders—Well laid and compact with no depression behind.

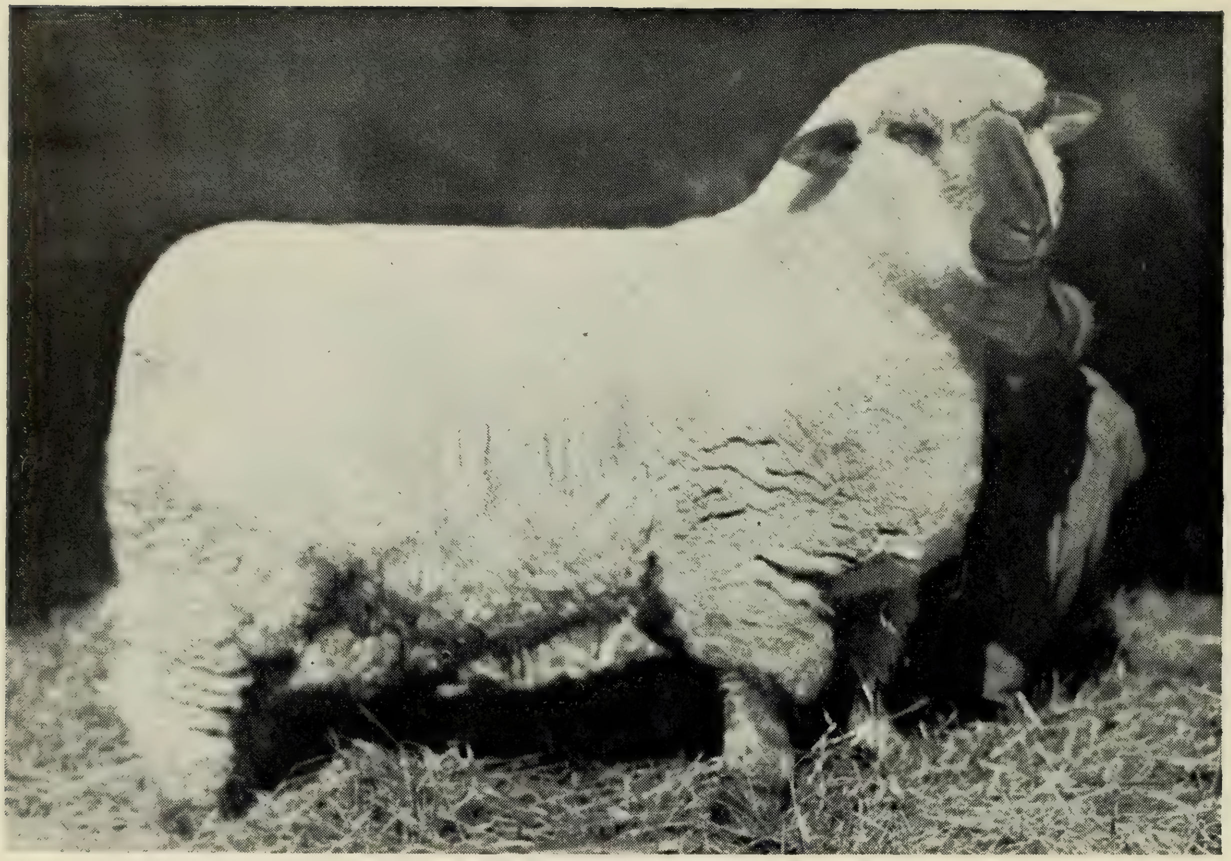
Back and *Loins*—Broad and straight, with well sprung deep ribs.

Quarters—Full, broad and deep, with flesh extending to the hocks.

Tail—Well set up in a line with the back, wide, firm and fleshy.

Legs—Well placed at the four corners, straight between the joints, with plenty of bone, well wooled to or below the knees and hocks.

Fleece—Of good staple and quality, compact and firm to the touch.



HAMPSHIRE DOWN

DESCRIPTION

Head—Face and ears of a rich dark brown—approaching to black, well covered with wool over the poll and forehead. Intelligent bright full eye. Ears well set on, fairly long and slightly curved. In rams, a bold masculine head is an essential feature.

Weight—Rams 250 to 325 pounds, ewes 175 to 240 pounds.

Neck and *Shoulders*—Neck of strong muscular growth, not too long, and well placed on gradually sloping and closely fitting shoulders.

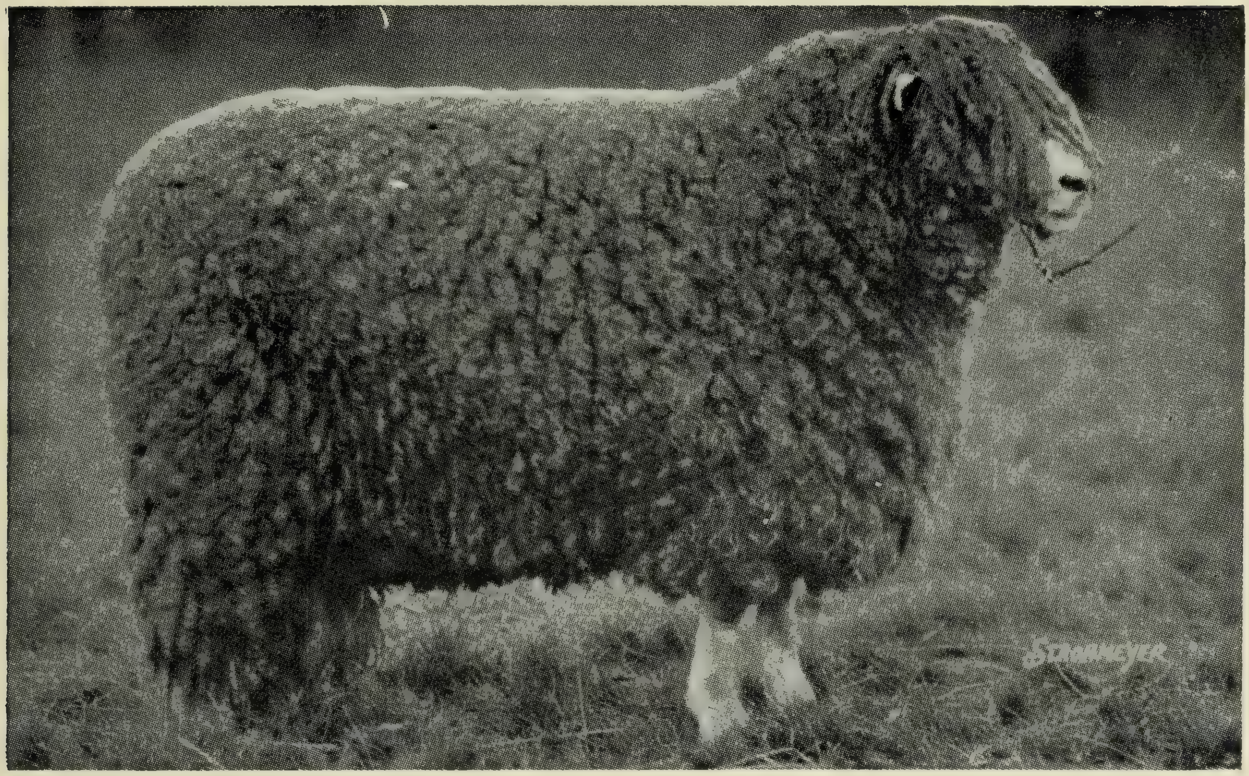
Carcass—Deep and symmetrical, with the ribs well sprung, broad straight back, flat loins, full dock, wide rump, deep and heavily developed legs of mutton and breast.

Legs and *Feet*—Strong jointed and powerful, legs of the same colour as face, set well apart, the hocks and knees not bending towards each other. Feet sound and short in the hoof.

Wool—White, of moderate length, close and fine texture, extending over the forehead and belly, the scrotum of rams being well covered.

Skin—Pink and flexible.

Objections—Snigs. White specks on face, ears and legs. Thick coarse ears. Black wool. Coarse wool on breeches. Protruding under jaw. Excessive loose skin under neck. Sickle hocks very objectionable.



LINCOLN

Good symmetry, shoulders well back with head up must stand straight and squarely.

Size—A Lincoln is essentially a big sheep, but this is not to mean length of leg only.

Weight—Rams 250 to 375 pounds; ewes 200 to 275 pounds.

Length and *Girth*—Length of body consistent with a deep, well sprung rib.

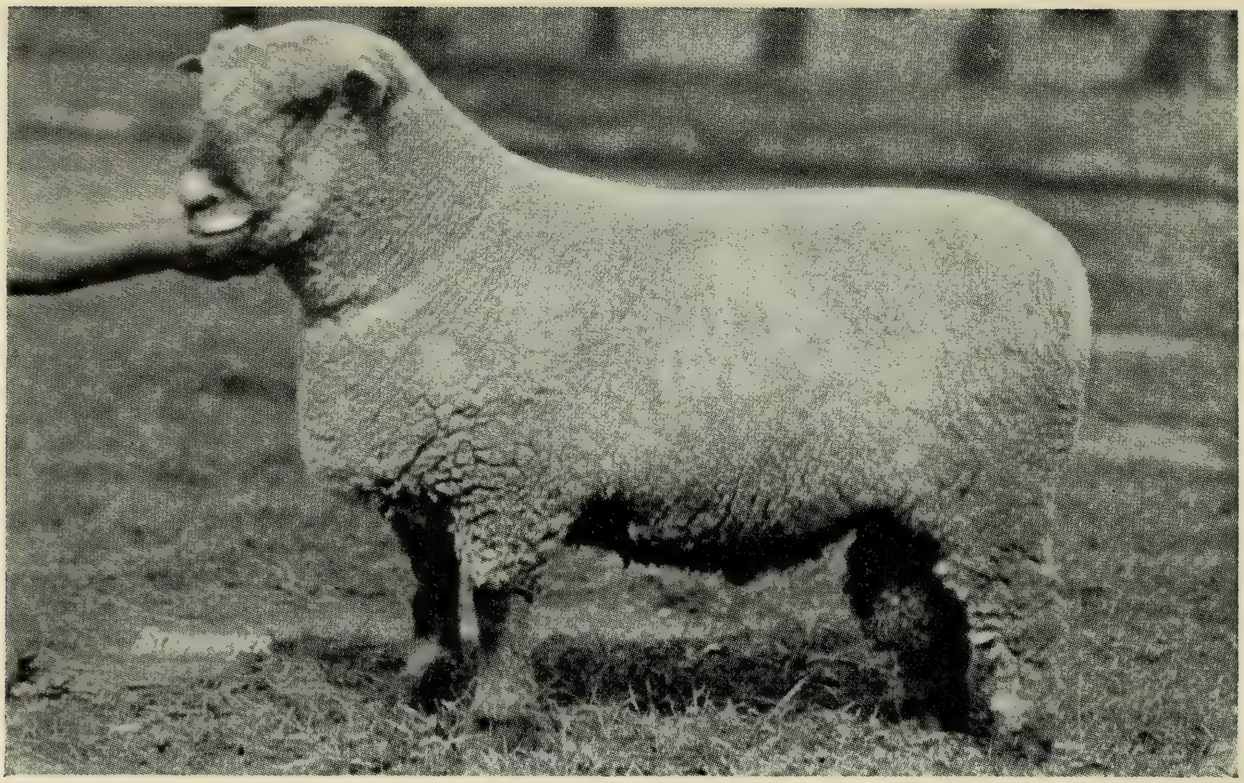
Head and *Ears*—A clear, bold eye, wide nostrils, blue skinned, not pink. Ears long and well placed, not pointing too forward or "lopping", white ears objectionable; colour should be a blue grey, mingled with darker spots. In rams head should show good masculinity, with deep wrinkles on forehead.

Bone and *Substance*—Plenty of good strong bone required to carry weight.

Activity—Free and gay.

Mutton—Deep, firm handling flesh along back, a wide loin, no hardness of touch on top of shoulder, a good wide "scrag". Leg of mutton well let down.

Fleece—Of great importance. Great weight of wool without coarseness; a broad, clean staple of fine lustre, that is, a wavy appearance in the lock; soft or what is termed "mossy" wool objectionable; no harsh, straight, hairy wool on thighs; head to be well covered and a broad forelock; breast and inside the thighs to be covered.



OXFORD DOWN

DESCRIPTION

General Appearance:

A well balanced conformation, free from coarseness in any part, and showing good style both at rest and in motion.

Head—Moderate length, with good width between the ears and eyes, and well covered with wool over poll and down to the eyes. Colour of face an even dark grey or brown, either with or without grey spot on tip of nose. Eyes bold, prominent and bright.

Ears—Medium size, not too thick and of an even brown or dark grey colour.

Neck—Strong and muscular in rams, and well set on in both sexes.

Weight—When fully matured and in good condition rams should weigh 250 to 325 pounds; ewes 180 to 250 pounds.

Legs—Short, strong in bone, flat and of even dark grey or brown colour, placed squarely under the body and well apart. Legs covered with white wool and extending preferably well below knees and hocks.

Constitution—Large around the heart and wide and full in the chest.

Form and Quality—Wide and straight on top of shoulders, back, loin and rump, from base of neck to tail.

Full shoulders, and thighs well meated both inside and outside.

Flanks well filled and strong so as to make the lower lines of the body as straight as possible, and side lines straight or rather full.

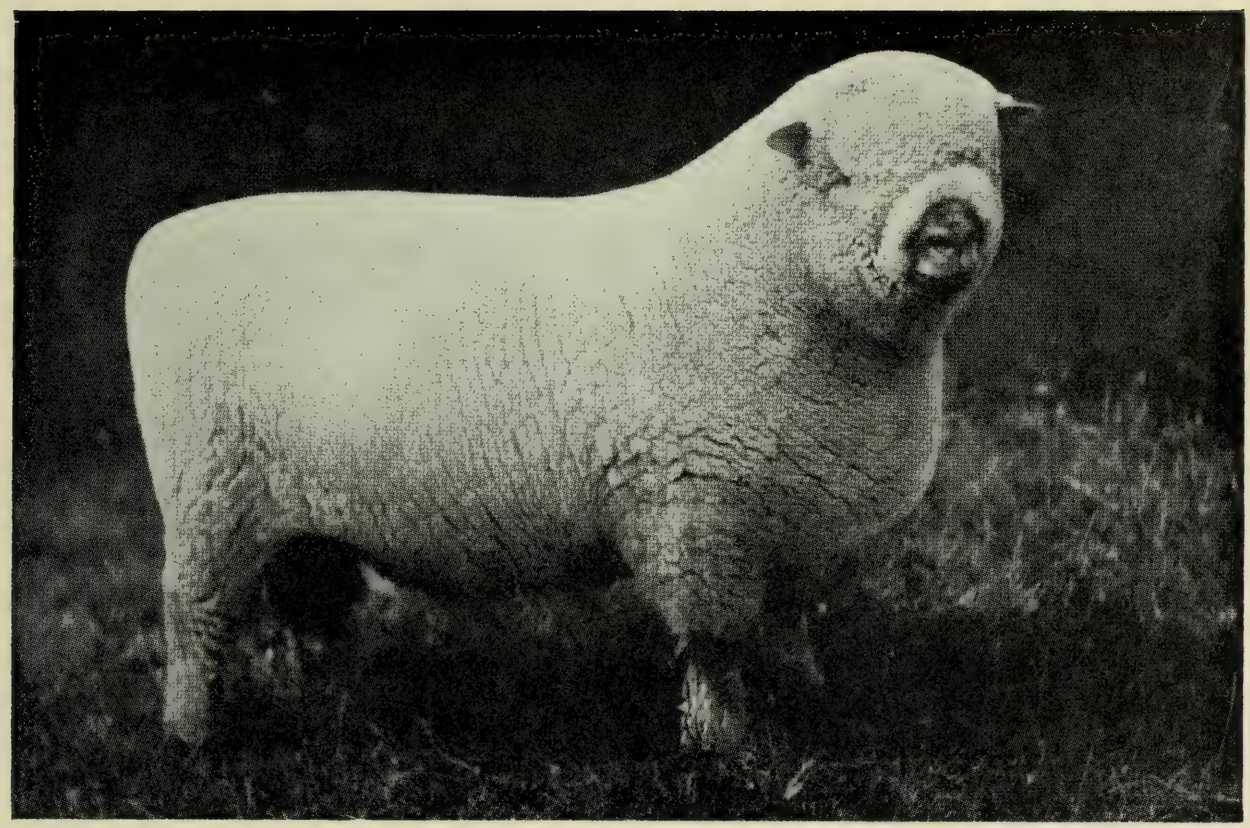
The whole carcass evenly covered with firm, deep and even fleshing.

Skin, bright pink in colour.

Wool—Fleece of moderate length, medium fineness, close and of even quality, covering the whole body and legs, and free from dark fibre and from black patches on body, neck and head.

Disqualifications—Black wool or fibre on any part above the knees and hocks, and back of the horn holes.

Objectionable Features—Coarse open fleece; horns; heavy drooping ears; long crooked legs, weak pasterns; long narrow face; brown or black wool on face or head.



SHROPSHIRE

DESCRIPTION

General Appearance:

Attractive, indicating breeding and quality, with stylish carriage and a symmetrical form, covered with fine, dense wool.

Constitution—Robust as indicated by width and depth of chest, strength and formation of neck, and by bold active movement.

Size—In breeding condition, when fully matured, rams should weigh 180 to 240 pounds; and ewes should weigh 140 to 200 pounds.

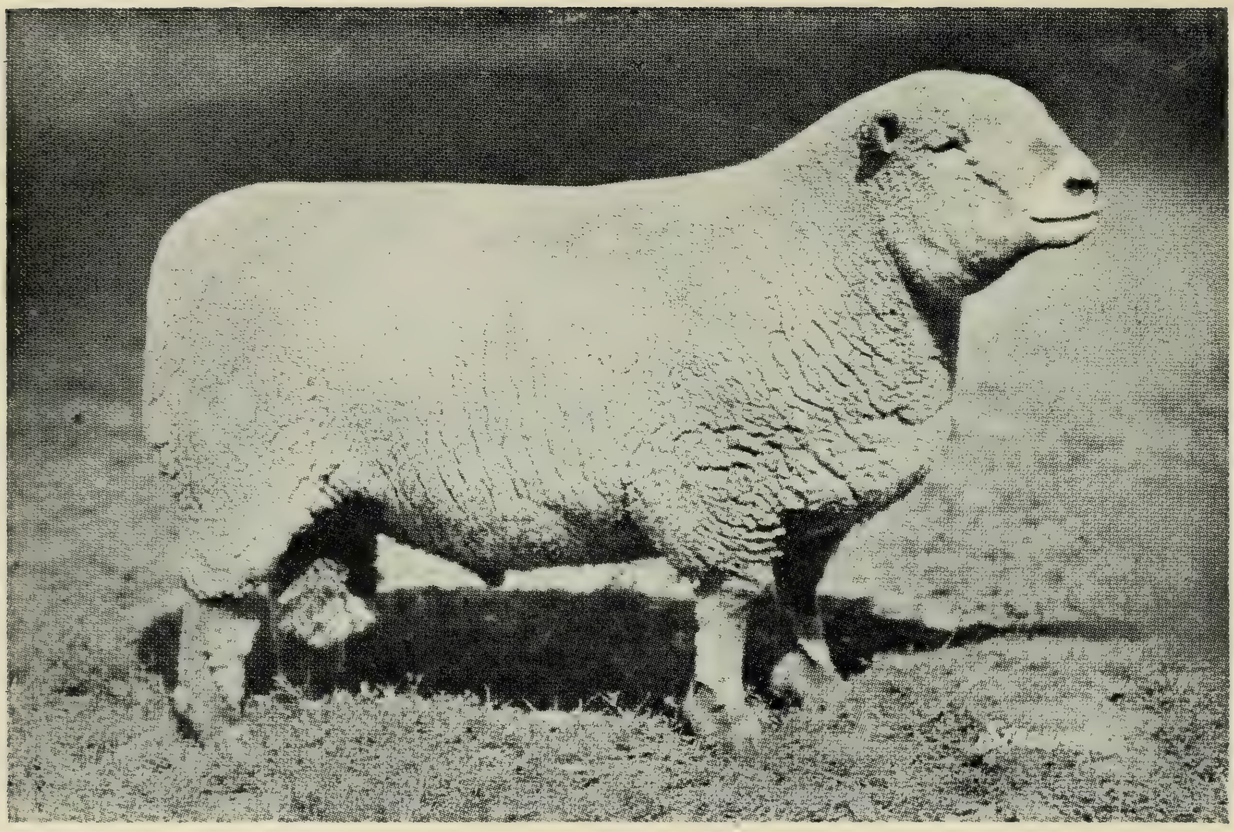
Fleece and Skin—Fleece of good length, dense, elastic to touch, medium fine, free from black fibre, well crimped, with evenness of texture throughout; scrotum of rams well covered with wool. The skin of a light cherry colour, clear and free from dark spots.

Body—Well proportioned, with shoulders well placed, fitting smoothly upon chest, which should be deep and wide, broad and straight back, thick loins, well covered with firm flesh; hind quarters well developed; twist deep and full.

Head and Neck—Head, short, broad between the ears and eyes, bold and masculine in rams, without horns; well covered with dense white wool; ears short and preferably wooled; eyes bright; colour of face and ears dark brown. Neck short, strong and muscular (especially in rams), symmetrically joined to head and shoulders.

Legs and *Feet*—Legs strong, short, straight, well wooled and well set apart; colour of hair on legs dark brown, and colour of wool on legs white; feet sound, short in the hoof, and square set.

Objections—What to avoid in buying or judging: Animals otherwise good, undersized; extremely long legs; narrow bodies; dark fibre in wool; dark skins; white specks on ears, face and legs; horns or horn stubs on rams; lack of wool covering on or underneath body, face and legs.



SOUTHDOWN

DESCRIPTION

Head—General character and appearance. Wide, level between the ears with no sign of scurs, or dark poll.

Face—Full, not too long from the eyes to nose, and of one even mouse colour, not approaching black or speckled, under jaw light.

Eyes—Large, bright and prominent.

Ears—Of medium size, and covered with short wool.

Weight—Rams 170 to 230 pounds; ewes 125 to 165 pounds.

Neck—Wide at the base, strong and well set on to the shoulders, throat clean.

Shoulders—Compact, well covered, with the top level with the back.

Chest—Wide and deep.

Back—Level, with wide, flat, thick loin.

Ribs—Well sprung, and well ribbed up, thick through the heart, with fore and hind flanks full and deep.

Rump—Wide and long and well turned.

Tail—Large, and set on almost level with the chine.

Legs of Mutton—(including thighs), should be full inside and outside, and well let down, with a deep wide twist.

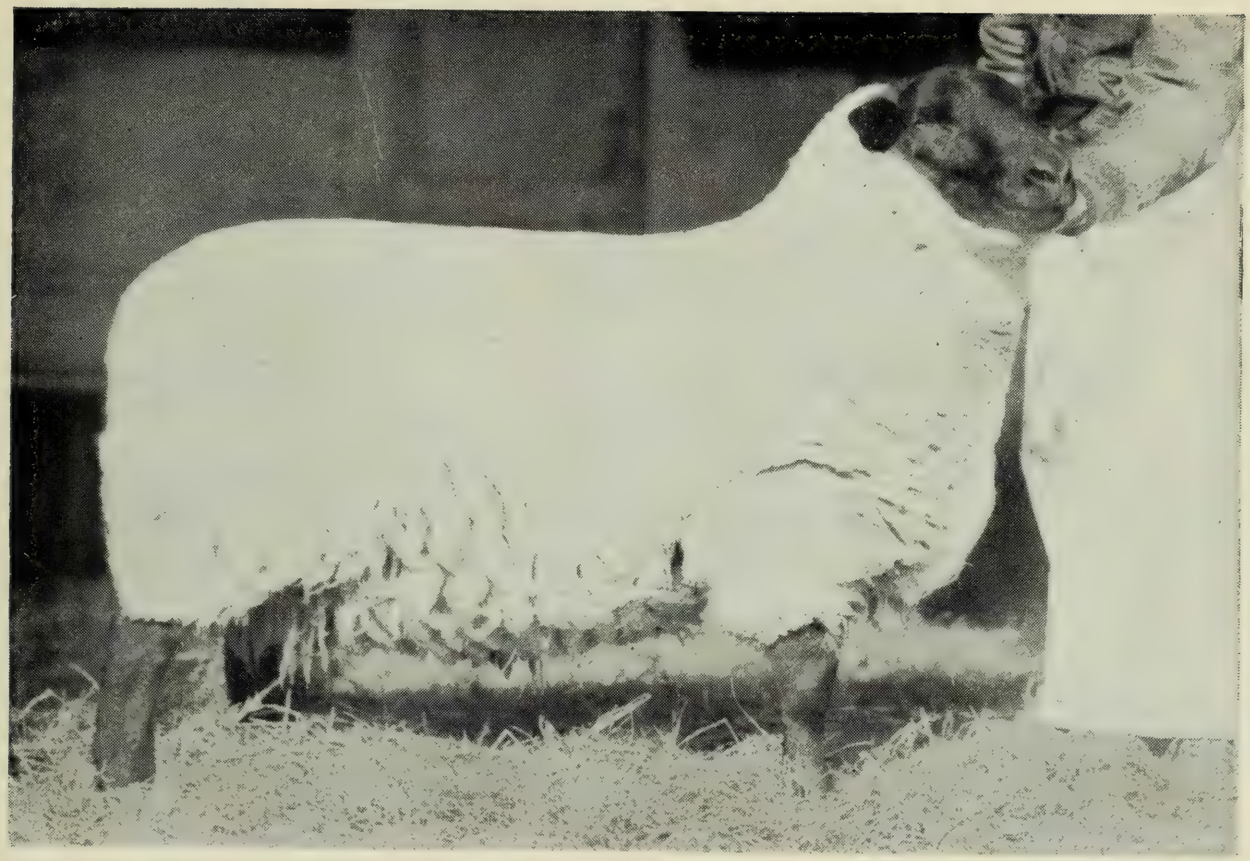
Wool—Of fine texture, great density, and of sufficient length of staple, covering the whole of the body down to the hocks and knees and right up to the cheeks, with a full foretop.

Skin—Of a delicate bright pink.

Carriage—Active, well balanced and stylish with legs short, straight, well set under the body and of one even mouse colour.

Disqualifications—The following are reasons why judges should not at breeding stock shows award a prize to otherwise good sheep:

(a) Horns, or evidence of their presence.
(b) Dark poll.
(c) Blue skin.
(d) Speckled face, ears and legs.



SUFFOLK

DESCRIPTION

Head—Hornless; face black (glossy black) and long, and muzzle moderately fine—especially in ewes. Ears a medium length, black and fine texture. Eyes, bright and full.

Weight—Rams 250 to 325 pounds; ewes 175 to 240 pounds.

Neck—Moderate length and well set. In rams stronger, with a good crest.

Shoulder—Broad and oblique.

Chest—Deep and wide.

Back and *Loin*—Long, level and well covered with meat and muscle; tail broad and well set up; the ribs long and well sprung, with a full flank.

Legs and *Feet*—Straight and black (glossy black), with fine and flat bone. Wooled to knees and hocks, clean below. Fore legs set well apart. Hind legs well filled with muscle.

Belly (also scrotum of rams)—Well covered with wool.

Fleece—Moderately short; close fine fibre without tendency to mat or felt together, and well defined, i.e., not shading off into dark wool or hair.

Skin—Fine, soft and pink colour.

SWINE

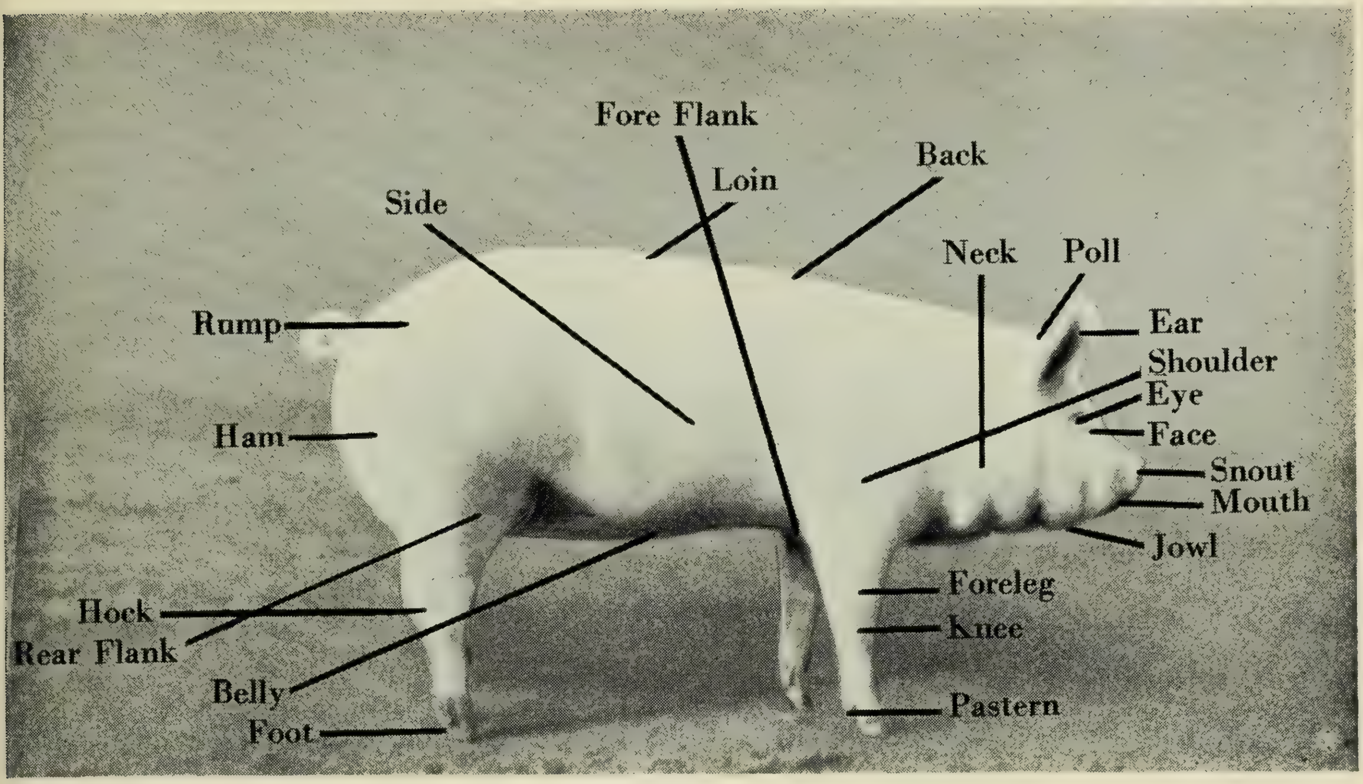
BACON TYPE

The Ontario farmer is concerned almost entirely with the bacon type hog. The introduction of compulsory carcass grading in 1940 served to focus attention to an even greater extent than previously on the production of a type of hog capable of yielding a high grade Wiltshire side on a profitable basis.

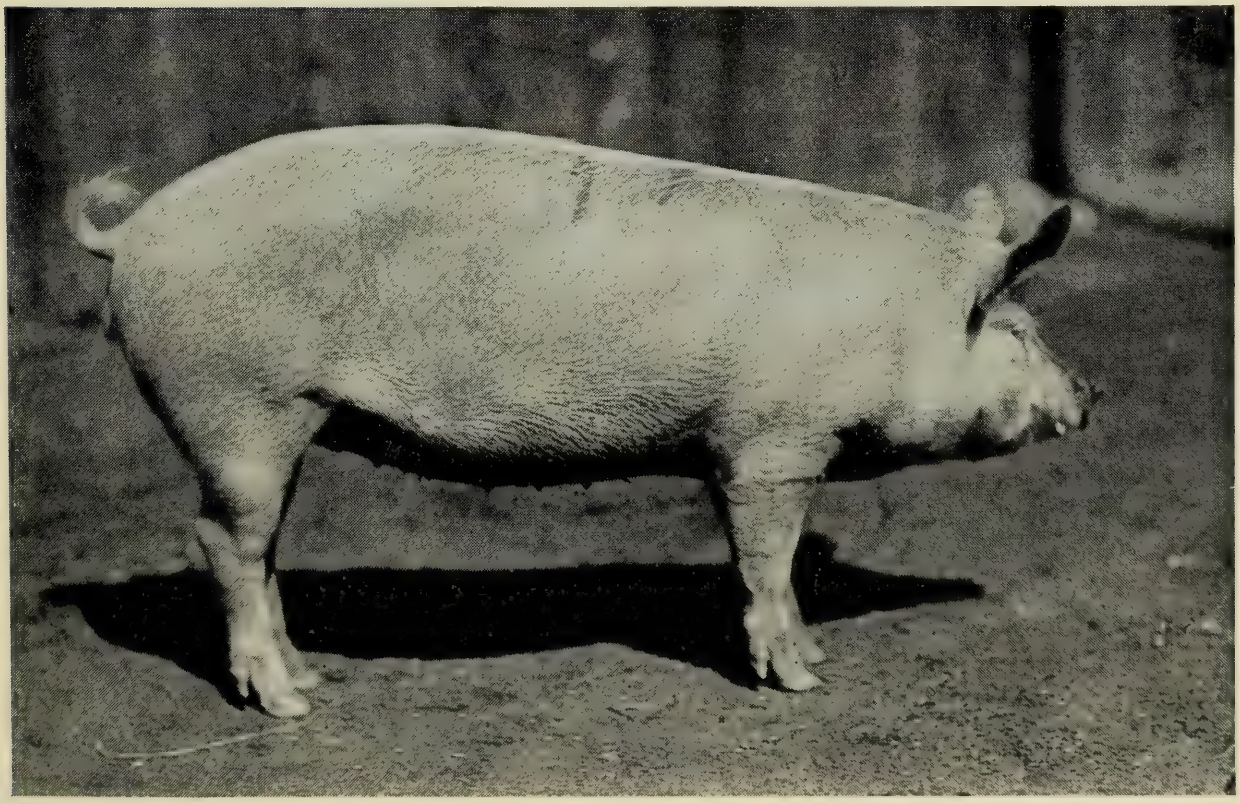
As to individuality, a bacon type hog should carry a balance of body. He should have length, trimness, smoothness and quality, and should show a reasonable amount of arch of back. He should have a clean-cut head with good width between the eyes and at the poll. The jowl should be firm and trim. His neck should be of medium length and muscular. The shoulder should be neatly set into the body with the shoulder blades well filled between with muscle. A bacon hog should have a sufficient depth of body along with width of chest floor to ensure a strong constitution. Without that strength we cannot expect best feeding results. His side should be of good length and flat, with the rib coming out from the backbone sufficiently far to give him width enough to allow the internal organs to develop and function properly. The loin should be deep and strong, and as wide as the rest of the back, and his rump should gradually slope to the tail head, being slightly rounded from side to side over the top with no indication of coarseness or flabbiness in that region. He should be just as deep and full at his rear flank as at his fore flank, which, with a trim belly line, should give him a full and practically straight underline. His ham should be smooth and firm, with the flesh carried well around the bone and tapering toward the hock. Great flabby bulging hams are not wanted on a bacon hog. If a straight edge were to be laid along his side it should touch at every point. As to quality and quantity of bone the bacon hog should possess a clean, strong bone, with no indication of coarseness about his joints, and he should stand straight and squarely on his feet. Any tendency toward weakness of pasterns is very undesirable. His hair should be of reasonable quantity and of good quality. Coarse, curly hair on a bacon hog is not indicative of quality. Extremes are to be avoided. The razor-backed hog is not a bacon hog. Neither is the narrow-chested, shallow-bodied, extreme hog an economical pork producer.

In a market class, the hog should be finished, but not overfat and should weigh at the market from 185 to 220 pounds, or from 190 to 225 pounds at the farm. While underfinish and lack of development are not desirable, wastiness and overfinish are more serious faults.

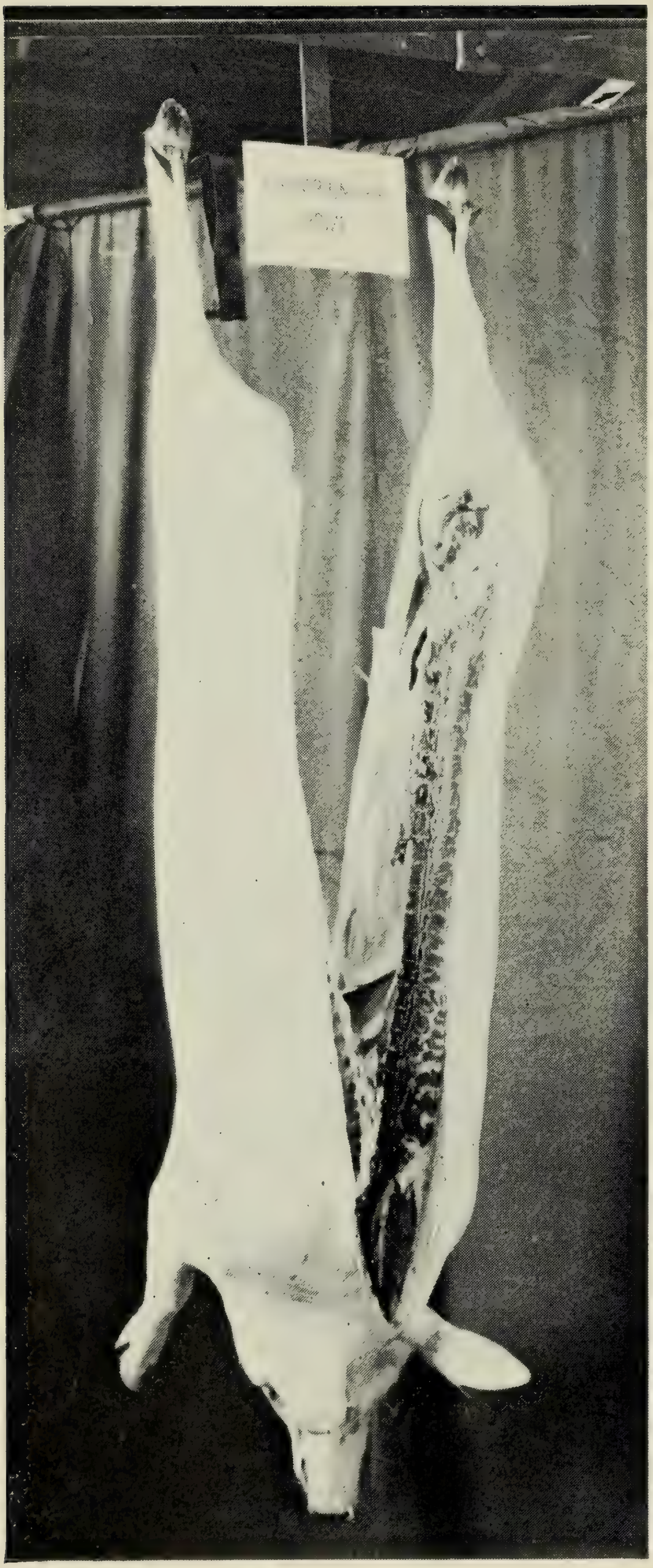
Hogs which are short, sloppy in the jowl, and coarse and heavy in the shoulder are nearly always degraded on the rail. The belly should be trim and neat and when on the walk there should be a general indication of firmness. Firmness denotes muscular tendency and muscular tendency denotes lean meat rather than fat.



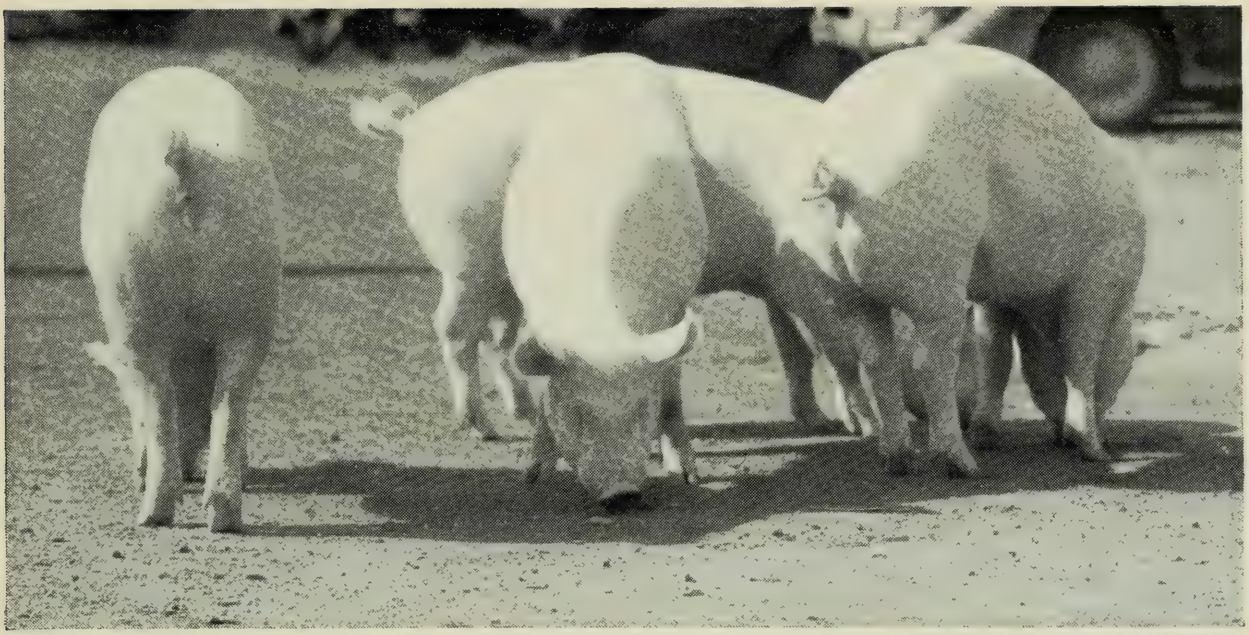
POINTS OF A PIG



A MARKET BACON HOG



A championship carcass showing length, balance, flatness of side and uniformity of back fat.



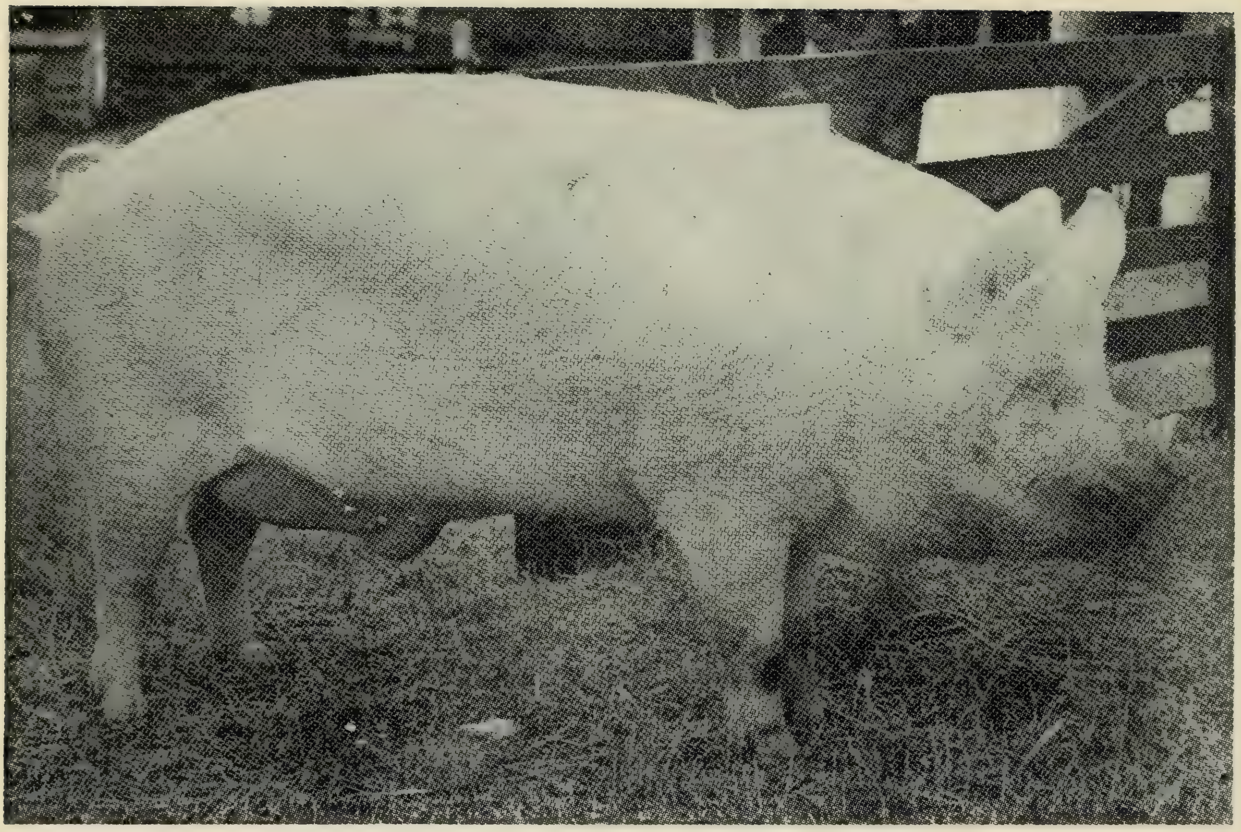
A group of Yorkshire Gilts.

BREEDS OF BACON TYPE HOGS

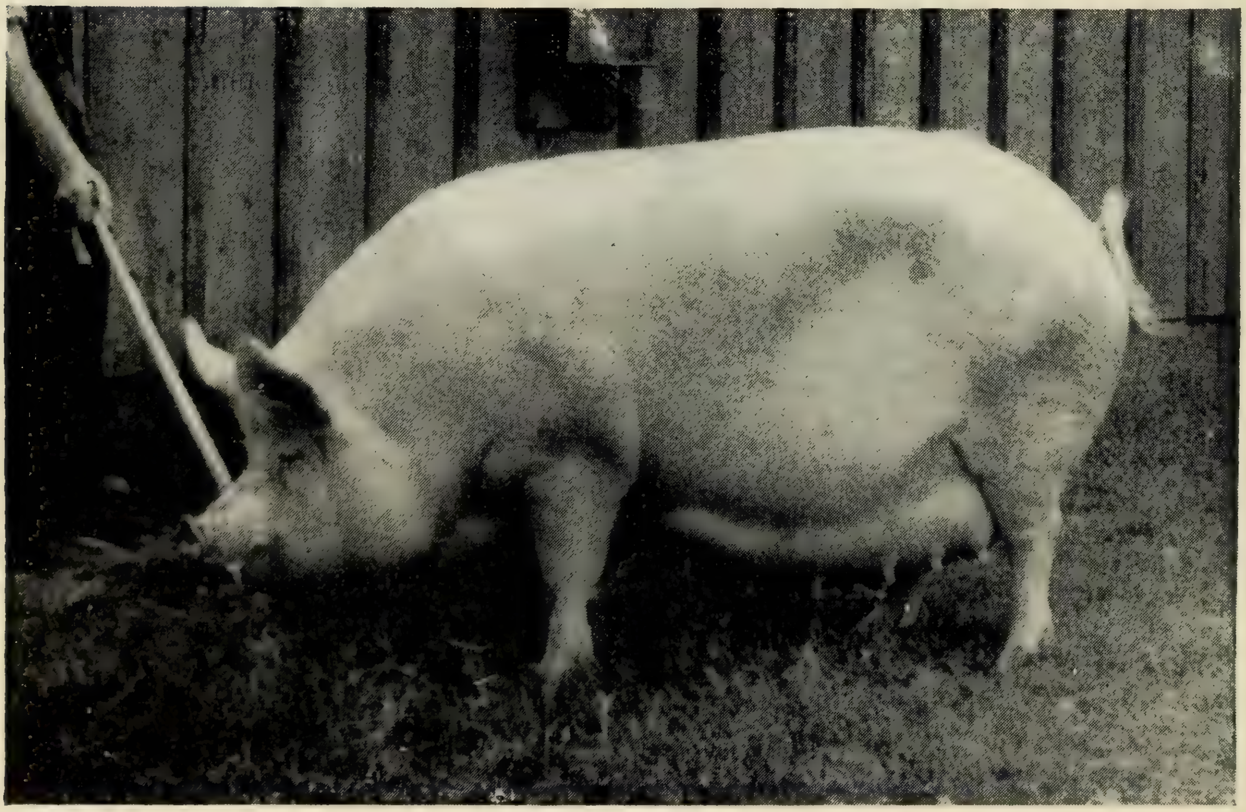
YORKSHIRE

The Yorkshire, or Large White, is, as the name would imply, one of the largest breeds of swine in Canada. In colour, a clear white is desirable. Black hairs or black patches of hairs are a disqualification but dark or bluish spots in the skin, while objectionable, do not disqualify, provided the hair is all white. Breeders try to avoid dark blotches in the skin. The Yorkshire is distinctly a bacon hog. The best specimens of the breed show a head of medium length with the face slightly dished and the nose practically straight. Considerable width between the eyes is characteristic of the breed. The ears should be of medium size, firmly attached to the head, and carried erect. The neck is of medium length and the jowl, while of fair width, is neat and trim, with no indication of flabbiness. The shoulders are compact and only medium in width and the sides should be long and fairly deep, with a trim underline, the whole side being so smooth that a straight edge laid along it would touch practically all the way from shoulder to ham. The ham should taper gradually from the twist to the hock and show no wrinkles. In bone, the Yorkshire should be strong and the body should be set on legs of fair length, not too long nor yet too short. All pigs, particularly breeding stock, should show plenty of strength of pasterns.

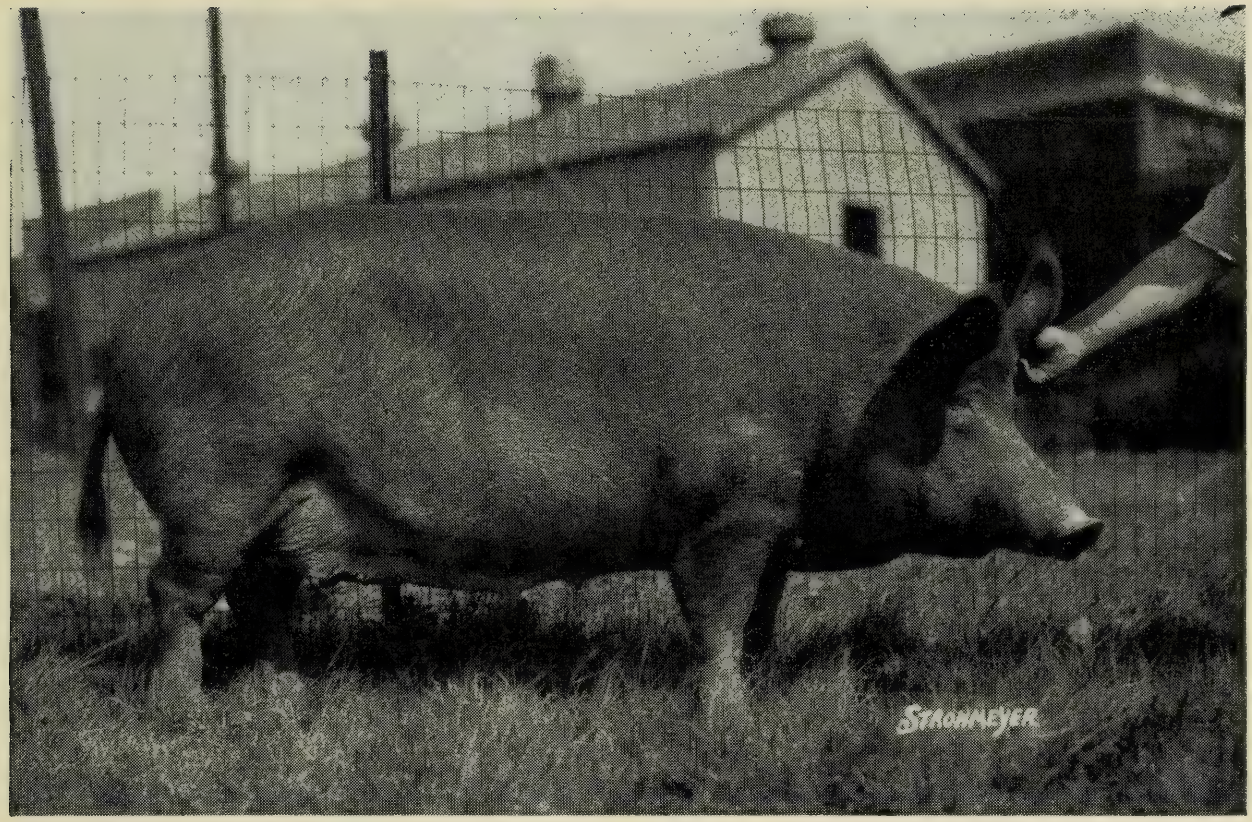
In 1946 the Yorkshire breed accounted for 88.3% of the total swine registrations of the Dominion.



A Yorkshire boar of good type.



A mature Yorkshire sow.



A champion Tamworth sow.

TAMWORTH

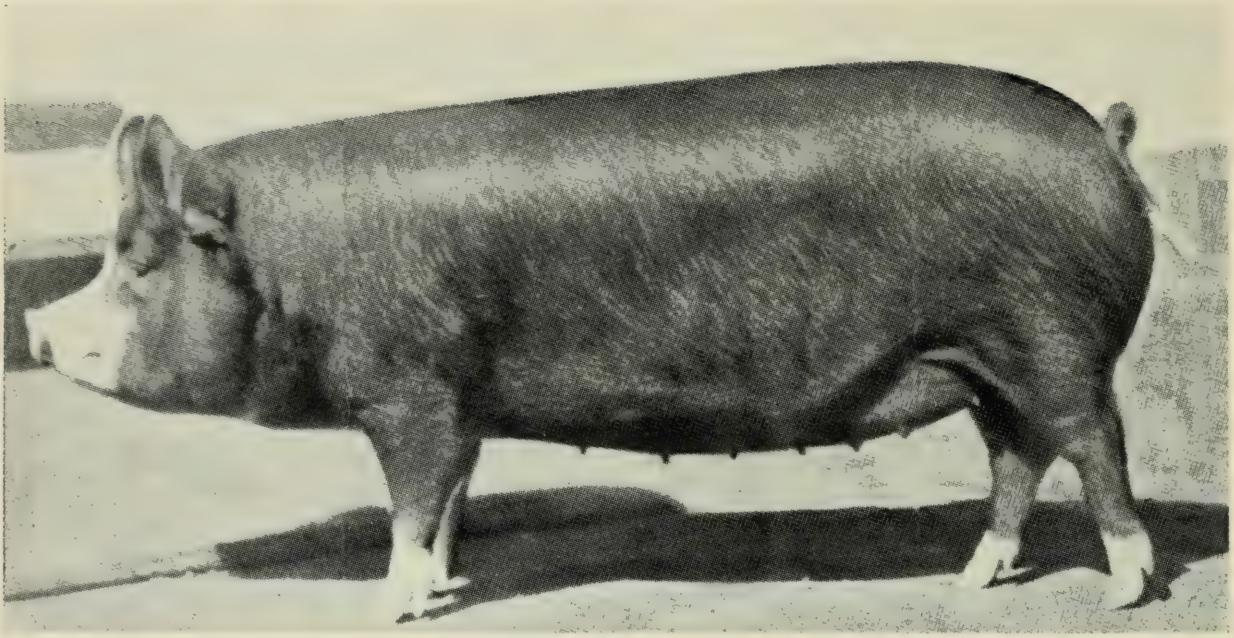
The Tamworth compares favourably with the Yorkshire in size. The colour is described as a golden red, with a flesh coloured skin free from black. The shade of red, however, varies a good deal from very light to quite a dark shade. It is noted that the colour generally grows darker with age. The face has a slight dish and the snout is rather long and straight. Narrowness between the eyes, while oftentimes noticed in this breed, is not really desirable. The ears are fairly large, not as thick as the Yorkshire's, firmly attached to the head and carried upright or inclined slightly forward. The neck is fairly long and the jowl shows the lightness and trimness of the bacon breeds. The shoulder is extremely smooth and medium in width; the side long and of good depth and the ham very trim and neat. The bone is fairly heavy and of good quality.

In 1946, 5.3% of the swine registrations in Canada were Tamworth.

BERKSHIRE

The Berkshire as it is bred in Canada today conforms a great deal closer to bacon type than did the old type of Berkshires. The colour is black, with white markings on the face, on the feet, and tip of tail. White blotches on the body are objectionable. The face of the Berkshire is slightly dished, the snout of medium length and the jowl full and fairly heavy. The Berkshire has a strong, broad back, with good thickness over the rump and through the ham. The Berkshire usually has a heavy ham which is generally quite trim. Depth of body is also characteristic of the breed and while the bone is sometimes rather light, the best individuals stand well on their legs. Berkshires, as a breed, show a considerable amount of quality.

In 1946, 5.0% of the swine registered in Canada were Berkshires.



A Berkshire Gilt of good type.

METHODS OF JUDGING SWINE

In judging swine, one is well advised to stand back some distance from the animal so that one is afforded an opportunity of getting a proper view of the hog. A hog should be made to move around while under inspection. When viewing him from the side, an idea of his general balance of body, his trimness, straightness of lines, depth of body, strength of constitution, arch of top, depth of loin, quality of bone, firmness of fleshing, the manner in which he stands on his feet, including strength of pastern, and quality of hair may be ascertained. A view from the front will show his clean cut appearance about the head, setting of ear, width of poll, width between the eyes, blending of neck into shoulder, and shoulder into body, and, to some extent, the evenness of spread throughout. An accurate idea of the width of chest floor also may be had from this viewpoint. The shape and development of ham and the filling between the hams may be discovered when standing at the rear of the hog. Moreover, one's impression as to the smoothness of top and uniformity of spread gained from the front view may be confirmed when viewing him from the rear. This latter position of inspection affords one a splendid opportunity to decide the amount of fleshing and the quality of fleshing which the hog is carrying. More information as to the manner in which the hog stands on his hind legs may also be had when standing behind him.

JUDGING BREEDING STOCK

In judging breeding stock, all the characteristics which have been mentioned under the heading of bacon type as applied to body conformation should be taken into consideration. The type of breeding stock is one of the main determining factors in the type of the commercial stock finding its way to our markets. Over and above these characteristics, sex characteristics should be given strict attention. In the case of the brood sow or breeding gilt, along with a feminine appearance there should be an indication of satisfactory mammary development. In both sexes there should be an indication of strength of constitution. While a boar should have sufficient depth of body to provide this requisite, it is well for a sow to have a still greater depth of body. The deep, flat-sided sow with a firm underline along with the other desirable characteristics already mentioned, mated with a boar of reasonable depth of body and of good type otherwise, should produce a desirable type of hog.

SCORE CARD FOR SWINE OF BREEDING BACON TYPE

Scale of Points:

GENERAL APPEARANCE—40 points

1. *Weight*—According to age.
   6 months—200 pounds
   9 months—320 pounds
   Mature —500–700 pounds for sows
   600–800 pounds for boars
2. *Form*—Well balanced, long, neat and trim, topline slightly arched, middle trim and free from flabbiness, side flat and deep.
3. *Style and Carriage*—Alert, with no evidence of swaying when on the walk as viewed from the rear.
4. *Condition*—Bloom, hair and skin indicative of thrift. Finish should be only moderate in all classes.

HEAD AND NECK—5 points

5. *Face*—Medium length, clean cut.
6. *Eyes*—Set wide apart.
7. *Ears*—Erect, medium in size, fringed with fine hair.
8. *Jowl*—Smooth, neat and trim, showing no signs of flabbiness.
9. *Neck*—Blending smoothly into shoulder.

FORE QUARTERS—10 points

10. *Shoulders*—Smooth, no wider than rest of body, compact on top.
11. *Chest*—Wide, deep and showing evidence of constitution.
12. *Front Legs*—Straight, showing bone of good quality, strong pasterns and toes showing no signs of weakness.

BODY—28 points

13. *Back* and *Loin*—Uniform in width from shoulder to ham, carrying moderate but not over finish.
14. *Sides*—Long, deep, flat, trim, showing no evidence of wrinkling, deep at front and rear flank.
15. *Underline*—Straight, trim, free from flabbiness and, in the case of breeding stock, having at least six pairs of evenly spaced teats.

HIND QUARTERS—17 points

16. *Rump*—Long to give size to ham, moderately flat with no excessive arching from side to side.
17. *Hams*—Full, tapering to the hock, free from wrinkling.
18. *Hind Legs*—Straight, bone moderate in amount, of good quality, pasterns strong.

SCORE CARD PARTS

The following is a description of the parts of the score card:

1. *General Appearance:*

The general appearance may be divided into weight, form, style and condition.

(1) *Weight*—It is essential that swine be well grown for their respective classes because this is the only estimate the judge is able to make of the hereditary tendencies toward rapid growth—an important aspect of swine production. Within classes, development and size are often important considerations in determining the final placing.

(2) *Form*—The bacon hog must be well balanced, showing good length of body and side, have a slightly arched top line, and show neatness, trimness and freedom from flabbiness throughout. A flat side, deep at both the front and rear flanks is important on account of the value of side bacon. The ideal bacon hog should be free from flabbiness in the jowl, free from wrinkling on the side, and while well filled in the ham, should show no wrinkling at the hock.

(3) *Style* and *Carriage*—The style of a pig is important because weaknesses in this respect often indicate weaknesses of bone or of set of legs. As viewed from behind, the pig should move true, with no evidence of swaying. Crooked legs are particularly conducive to poor style.

(4) *Condition*—Pigs as shown in all classes should show evidence of thrift and should carry only a moderate amount of finish. Over-finish often serves to cover up weaknesses in a pig. In market classes, it is particularly undesirable and in breeding classes should be discouraged.

2. *Head and Neck:*

(5) *Face*—The face should be medium in length and slightly dished. There should be a clean cutness throughout. Extremely short, turned-up faces are often associated with heavy-jowled, short pigs, and while once in fashion, are now definitely to be discouraged.

(6) *Eyes*—The eyes should be set wide apart, even in those breeds possessing long heads.

(7) *Ears*—The ears should be from medium to fairly large in size and should be held erect. They should be fringed with fine hair.

(8) *Jowl*—In the ideal bacon hog, the jowl should be smooth, neat and trim, and show no signs of flabbiness. Thick, flabby jowls are often found in pigs with heavy shoulders that tend to be wasty throughout.

(9) *Neck*—The neck should blend smoothly into the shoulder and while showing strength, should show no crestiness.

3. *Forequarters:*

The forequarters in a bacon hog constitute the less valuable cuts. While there should be sufficient strength of forequarter to carry the hog, on the other hand heaviness in the forequarters is looked upon with disfavour.

(10) *Shoulder*—The shoulder in a bacon hog should be neat, smooth and well set in. It should be compact, especially on top. It should show no signs of heaviness and should be no wider than the rest of the body. It is often found that good hammed pigs tend to be likewise heavy in the shoulder, but the aim in the production of a more

balanced bacon hog is to seek for lighter, smoother shoulders and heavier hams. In some cases, it becomes a matter of decision as to whether a heavier shouldered hog is to be placed up in spite of its heavy shoulder but on account of its good ham, over a lighter shouldered, smaller hammed hog. Because of the importance of a light shoulder in present-day bacon production, it is advisable to discount a heavy shouldered hog rather severely.

(11) *Chest*—The chest should be broad and moderately deep, indicating strength of constitution.

(12) *Front Legs*—The front legs as viewed from some distance ahead of the hog should be straight and show bone of good quality. There should be no sign of knuckling in or twisting of the front legs. Pasterns should be strong. There should be no tendency for the hog to walk on its dew claws. The toes should be carried close together and there should be no signs of splaying. There is certain evidence to indicate that crookedness in the front legs of hogs is due to an unequal development of the toes of the pig, and that the tendency towards this condition is hereditary.

4. *Body:*

In the body region we find a side of bacon and the loin. Both of these are valuable cuts and for this reason we require: first, length; second, depth; third, flatness; and fourth, trimness of side.

(13) *Back* and *Loin*—As viewed from both the front and the rear, the bacon hog should show a moderate but uniform spread throughout the entire length of body.

(14) *Sides*—As viewed from the side, the middle should show length and uniformity of depth and trimness of underline. Shortness of middle and lack of trimness not only reduce the value of this section, but are also associated with thickness and coarseness throughout. On the other hand, excessive length resulting in a lack of depth and constitution, while preferable to shortness, is not to be favoured.

(15) *Underline*—The underline should be firm to indicate a high percentage of lean tissue. Soft, flabby underlines are usually associated with wasty bellies in the carcass. Because of the importance of mammary development, breeding stock should have at least six pairs of evenly spaced teats. An even number of teats is much to be preferred over an odd number. Different numbers on each side leads to an uneven udder development. The teats should be uniformly spaced and should be normal in size. Mature sows should show no breaking away of the rear udder.

5. *Hind Quarters:*

Like the middle, the hind quarters constitute a valuable part of the final bacon carcass.

(16) *Rump*—The rump or quarter in the hog should be long and slightly arched. Shortness of quarter is associated with shortness in the ham. Flatness in the rump as viewed from the side or arching as viewed from the rear are undesirable.

(17) *Hams*—The hams should be full, showing no sign of being cut off at the rear. They should show evidence of good fleshing, both as viewed from the side and the rear. Fleshing should taper down to the hock, and there should be no wrinkling around the hock.

(18) *Hind Legs*—The hind legs should be straight. The bone should be moderate in amount, but of good quality. The pasterns should be strong, and while on the walk the legs should move freely and be straight as viewed from behind.

THE JUDGING OF SWINE CARCASSES

In the swine carcass, the ultimate product comes under careful examination. Quality in bacon hog carcasses is becoming increasingly important and the final test of a breeding and feeding program is the quality of the carcass produced.

Because of the difficulty of relating outward form to carcass quality, live grading was replaced by compulsory rail grading in 1940. A knowledge of the official grades is essential as the first step in the judging of bacon hog carcasses.

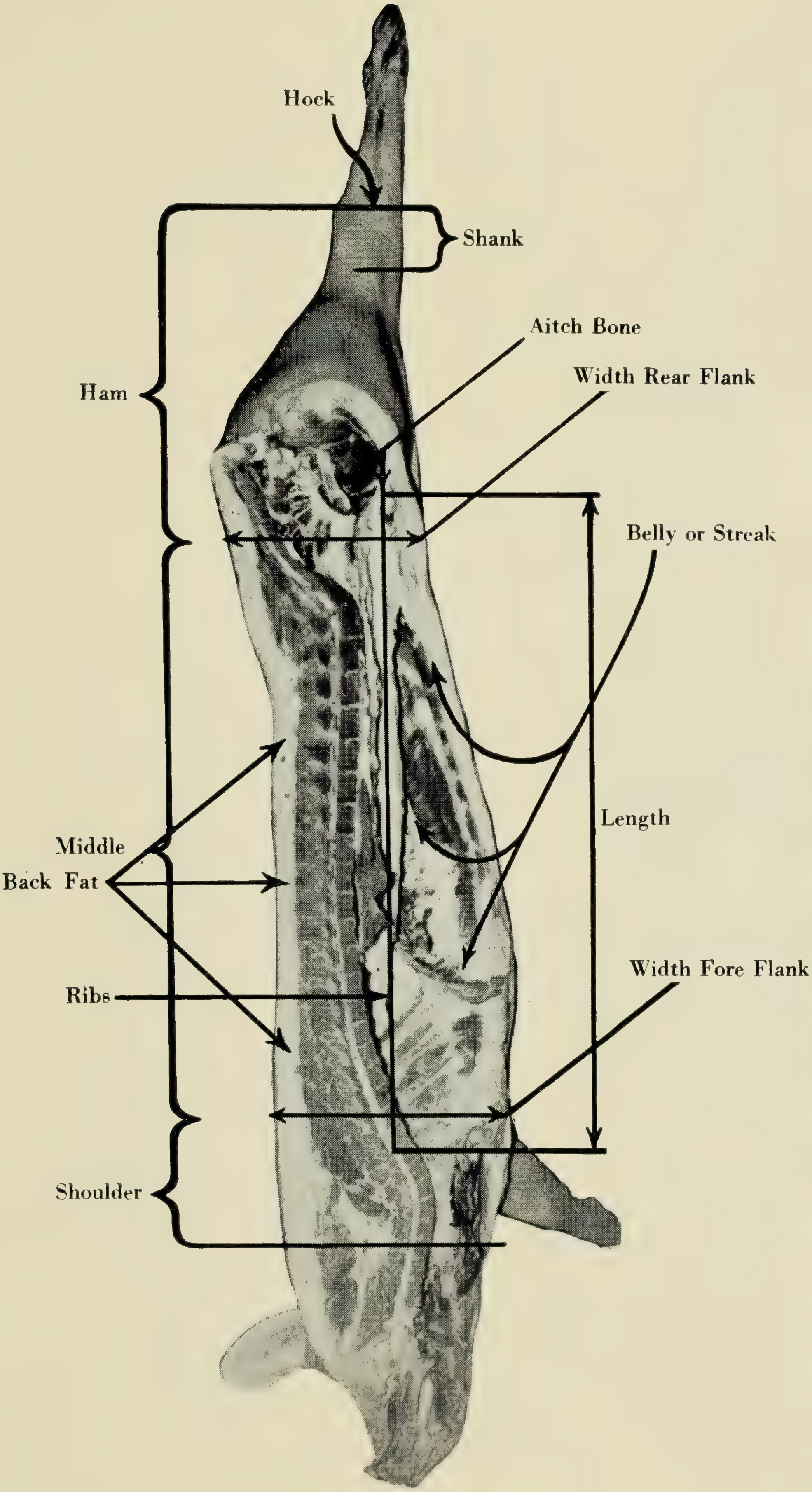
THE CARCASS GRADES—REQUIREMENTS

Grade	*Weight Range*	*Minimum Length*	*Maximum Shld. Fat*	*Maximum Loin Fat*
A	140–170 lb.	29″	2″	1½″
B1	135–175 lb.	28 to 29″	2 to 2¾″	1½ to 2″ accord. to wt.
B2	125 134 lb.	27″	2″	1½″
B3	176–185 lb.	30″	2¾″	2¼″
C	120 185 lb.	none	2¼ to 3¼″	1¾ to 2½″ accord. to wt.
			May be overfat, lacking in length, type or balance	
D	120–185 lb.	none	May be very fat, short or lacking in balance. Also includes unfinished, rough, soft or oily carcasses of any weight	
Lights	119 lb. and under	Shall have reasonable finish and quality		
Heavies	186–195 lb.			
Extra Heavies	196 lb. and over			

While the grade requirements are rigidly set, there is within each grade room for considerable variation. In judging swine carcasses they are placed:

(1) On grade
(2) Within grades

Carcasses are appraised from the standpoint of their suitability for the production of Wiltshire sides. The points of a carcass, the names of which should be familiar to the judge are illustrated in the accompanying cut.



POINTS OF A CARCASS

ANALYSIS OF THE CARCASS

Each carcass should be analyzed carefully under the following headings:

1. Weight
2. Type:
    - (a) Balance
    - (b) Length
    - (c) Flatness of rib and side
3. Amount and uniformity of finish (back fat)
4. Firmness of fat
5. Quality of belly
6. Fullness and trimness of ham
7. Condition and colour of skin.

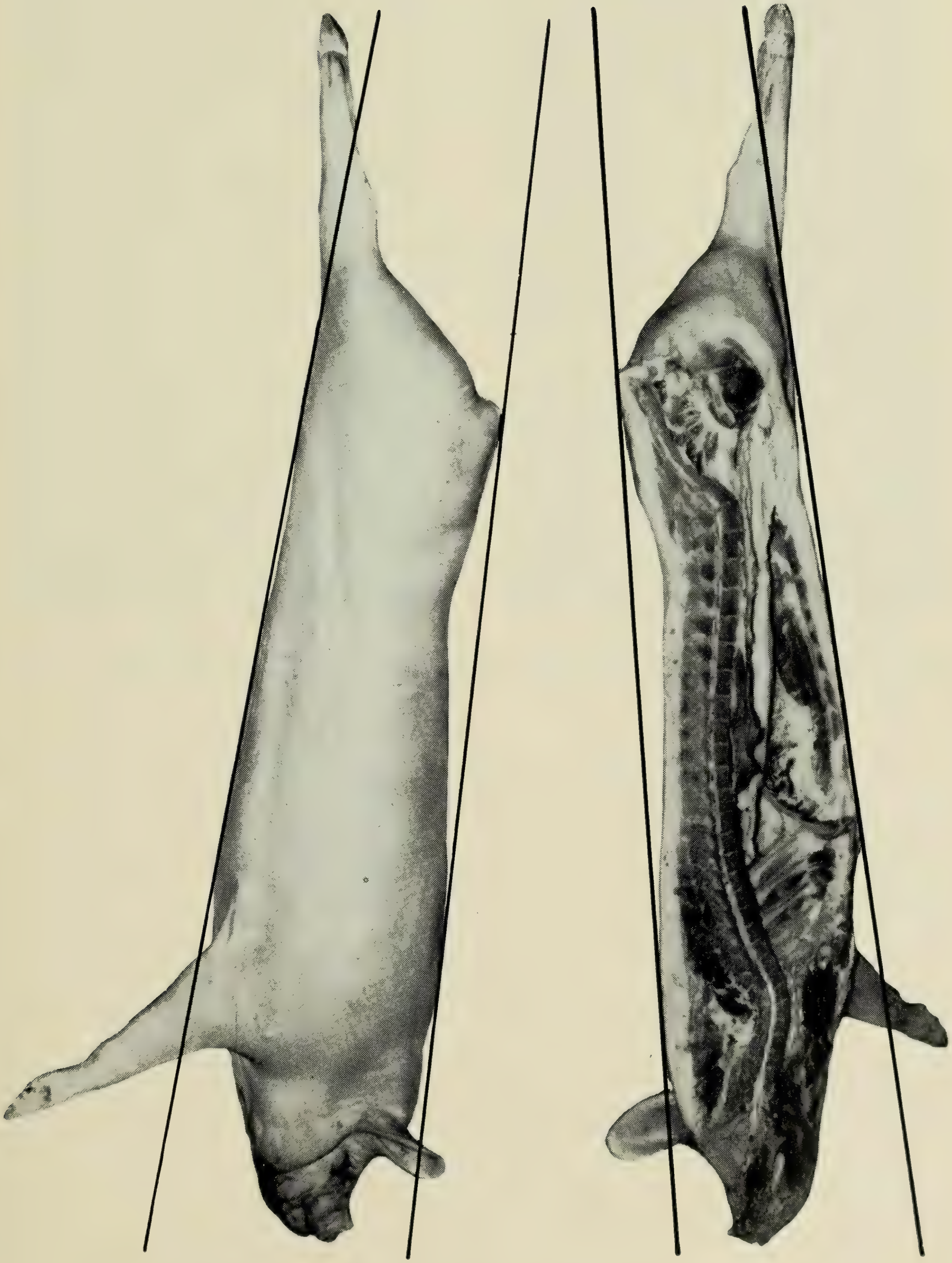
1. *Weight*—The hot carcass weight tag should always be consulted because at times carcasses are outside the A Grade weight range of 140 to 170 pounds. A carcass that is degraded on account of weight, no matter how good in type and finish, places below all A carcasses in the class.

2. *Type*—

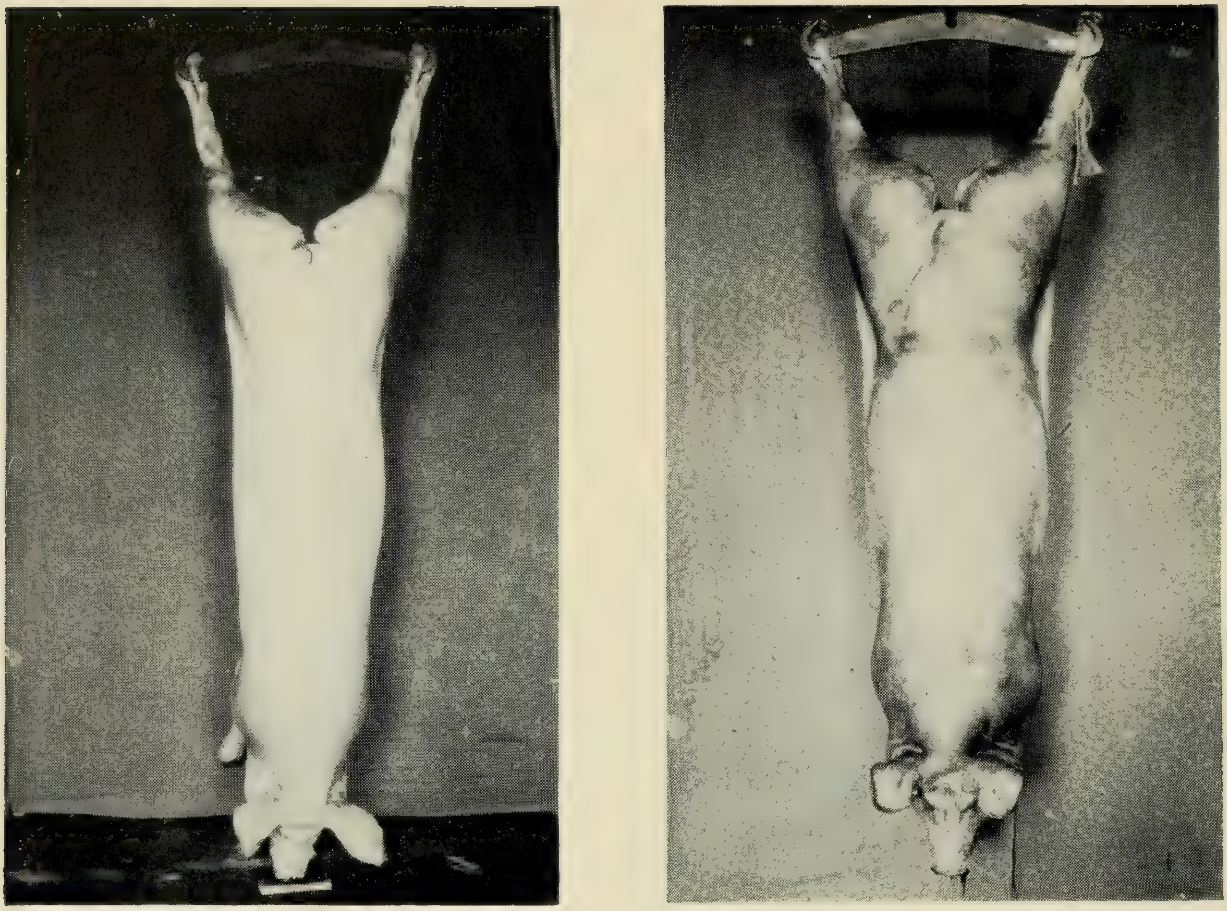
(a) Balance. The balance of a carcass which indicates the relative proportion of shoulder to middle to ham is determined by viewing it from both the skin and the flesh sides. A carcass of good balance is one in which imaginary straight edges placed along the top and underline could be projected without meeting. This requires that the carcass be as deep in the rear as in the fore flank. The parallelism of the top and underline can be determined by standing well back and running the eye up and down the carcass. Poorly balanced carcasses tend to be deeper in front than at the rear flank. Such carcasses are heavy in the shoulder and lack in uniformity of depth.

(b) Length. In addition to being well-balanced, the ideal bacon carcass should possess good length. The length of a bacon hog carcass is measured from the aitch bone to the front of the first rib, but in judging it is usually a matter of comparison. While length is desired, on the other hand excessive length is unnecessary. Short carcasses, though, even if well-balanced, may be found to be over fat.

(c) Flatness of Rib and Side. The side of a bacon carcass should show a good flat rib, with no tendency to roundness. This flatness of rib should be carried throughout the length of the carcass. Heavy-shouldered, round-ribbed carcasses are definitely regarded as being off type. These two conditions result in such a carcass being degraded.



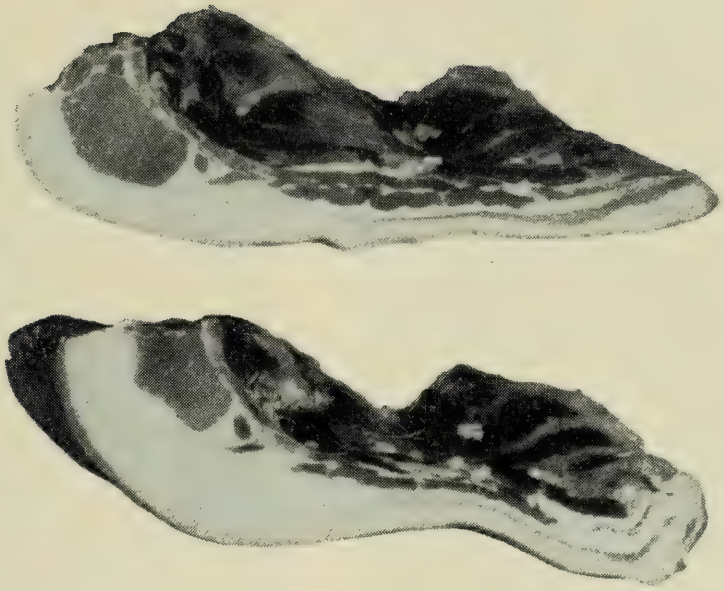
Skin side and flesh side views of a well-balanced carcass.



The good type carcass on the left shows length, smoothness of shoulder and flatness of side, in contrast to the shortness, heaviness of shoulder, and roundness of rib of the poor type carcass on the right.

3. *Amount and Uniformity of Finish*—More carcasses are degraded on account of over-finish than for any other reason. The maximum fat measurements for an A Grade carcass are 2.0 inches at the shoulder and 1.5 inches at the loin, or at any other point back of the loin. Because of the weight range allowed for A carcasses (140 to 170 pounds), these measurements, while acceptable for the heavier carcasses within the range, actually constitute over fatness in those carcasses in the lower end of the weight range. While 2 inches is the maximum for shoulder and 1.5 the maximum for loin, a shoulder fat ranging between 1.7 and 1.9 and a loin fat ranging between .9 and 1.3, depending upon weight within the A range, is ideal. The more uniform the covering of the back fat, the more desirable, providing the carcass is neither over finished nor under finished. The thinnest point in the fat layer is usually found in the middle of the back. For the most uniform back fat (providing the shoulder and loin fat measurements are ideal), the middle of the back should measure not less than 0.8 to 1.0 inches, depending upon the weight of the carcass. While over fatness is more to be condemned than a slight under-finish, definite lack of finish (minimum back fat less than 0.6 inches) is sufficient reason for placing a carcass down, because such lack of finish will be accompanied by a thin, flabby belly.

4. *Firmness of Fat*—Very little difficulty is encountered with this item but on certain rations fat firmness is affected. Unless the fat is notably soft on being pressed with the thumb, no differentiation between carcasses is made on this characteristic.



Belly cross-sections showing eyes-of-lean and bacon rashers.

(Top) ***Desirable—From a hog of good breeding, fed a balanced ration, and marketed at the proper weight.***

(Bottom) ***Undesirable—Fed an inferior ration and marketed too heavy.***

5. *Quality of Belly*—If the carcasses are sectioned, the belly quality is easily determined by examining the end of the cross section. This should show evidence of:

(1) Thickness.

(2) High percentage of lean to fat.

(3) High degree of dispersion of the fat among the lean tissue.

(4) An even distribution of lean throughout the length of the bacon rasher.

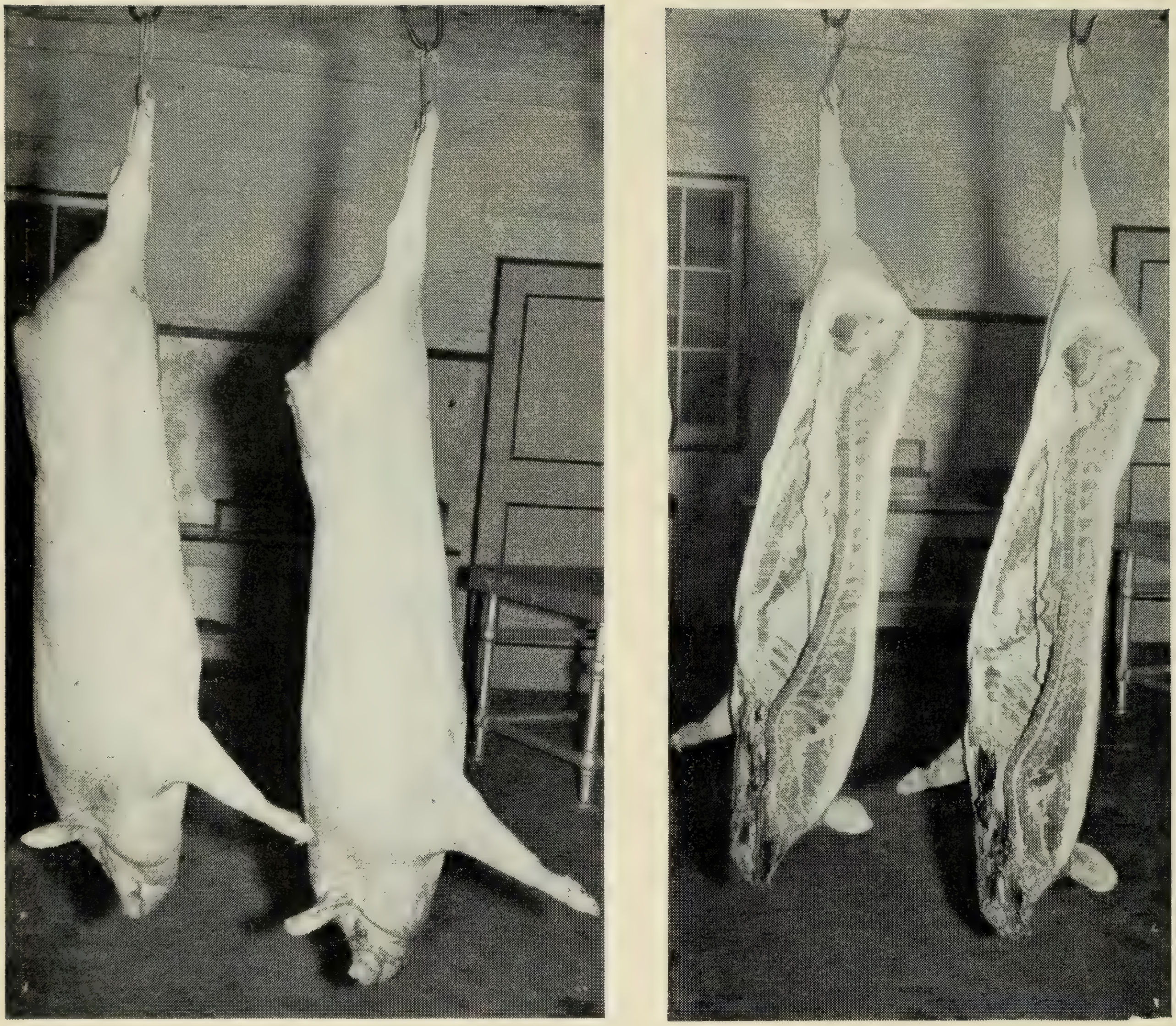
(5) A well-developed eye-of-lean or loin muscle.

(6) An even covering of fat with no evidence of bulging.

If the carcass is not sectioned, some idea of the belly quality can be ascertained by determining the thickness of the flank and belly by grasping these parts between the thumb and fingers.

6. *Fullness and Trimness of Ham*—The ham is one of the more valuable cuts and should be full and firmly fleshed. It should taper gradually to the hock and show no evidence of wrinkling. Fullness of ham should be the result not of excess fat, but of a high proportion of lean meat. Our best bacon hogs carry plump, full, well meated hams, but many have hams which are shanky in appearance and could be improved by more filling.

7. *Condition and Colour of Skin*—The skin should be clear in colour and free from evidence of dark hair roots or pigment. The skin should be free from bruises, but minor blemishes such as minor knife cuts, surface scratches or small bruises do not disqualify a carcass.



The two carcasses shown from the skin and flesh sides are identical in weight (157 pounds). Both graded A, but it will be observed that there are some rather marked differences between them. The carcass on the right, the more desirable, is slightly more evenly balanced and has two inches more length. The back fat on this carcass, while not much more uniform than that of the carcass on the left, is more nearly ideal. The back fat on the carcass on the left measures 2.0 inches at the shoulder, 1.1 inches in the middle of the back, and 1.5 inches at the loin. That is, the shoulder and loin measurements are well up to the maximum permitted for A Grade. On the other hand, the carcass on the right carries 1.6 inches of shoulder fat, 0.9 inches of fat in the middle of the back, and 1.3 inches on the loin. We thus see the difference between a border-line A and an acceptable A. The carcass on the right would have been improved had there been less wrinkling of the belly and a somewhat fuller ham.

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Breeds of Live Stock in Canada—*MacEwan*

Judging Dairy Cattle—*Harrison*

Selecting, Fitting and Showing Beef Cattle—*Nordby and Lattig*

Productive Horse Husbandry—*Gay*

Judging Live Stock—*Craig*

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CHEDDAR CHEESE MANUFACTURE

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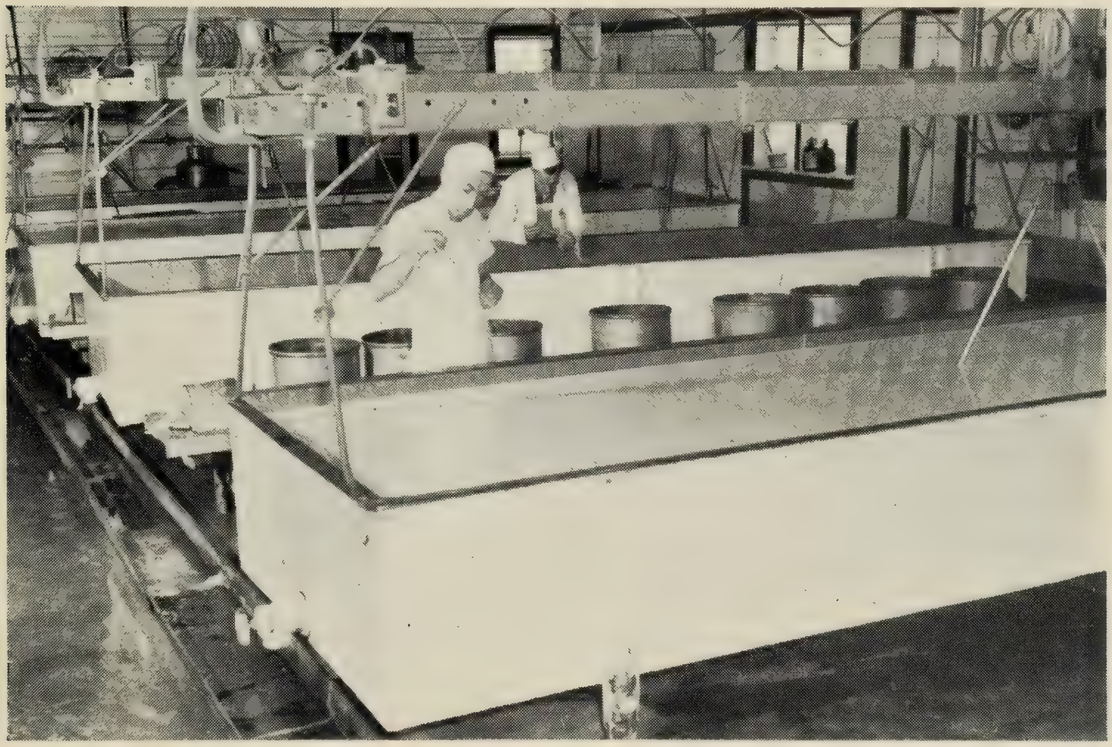

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CHEDDAR CHEESE MANUFACTURE

INTRODUCTION

The chief objective in preparing this bulletin has been to describe, as clearly as possible, up-to-date, proven, commercial practices used in Cheddar cheese manufacture. In addition, however, some of the principles upon which cheesemaking is based have been discussed and reference is also made to the important Dominion and Provincial legislation with which cheese factory operators must be familiar. It is hoped that students and apprentices of this art, as well as its master craftsmen, will find it of value as instructive material.

The Province of Ontario has long had reason to be proud of its cheese industry. For decades our reputation for quality in overseas markets has been second to none. In point of volume too, Ontario has always been the leading Canadian producer. History has been partially responsible for the emphasis on cheese in this section of Canada since this product was for many years the only one for which factory methods had been devised. Shortly after the beginning of the century, methods for large scale manufacture of butter and concentrated milk came into use and now compete strenuously for the supply of milk sold for manufacturing purposes. It is important to note however, that the high reputation for quality which our cheese enjoys in export markets, makes it advisable to dispose of our

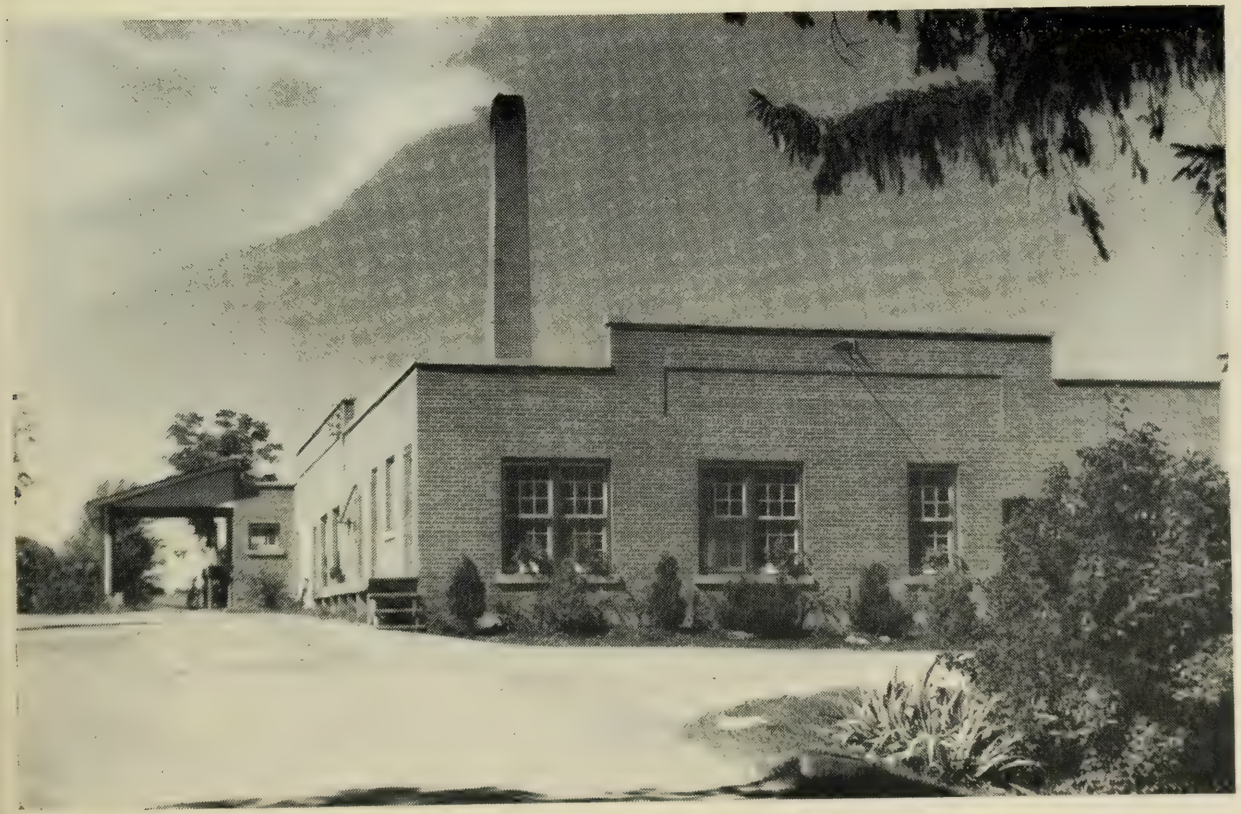

FIG. 1 The exterior of the factory should present a clean-cut, well-constructed appearance. Window boxes and shrubs add greatly to the appearance of this plant at Tavistock, Ontario.

national supply of "surplus milk" through this channel rather than as other products which so far have not gained as favourable a name abroad. The economic health of Canada's whole dairy industry is accordingly closely related to the terms on which our export cheese is sold.

ESTABLISHING THE FACTORY IN A COMMUNITY

The chances for success of a considerable number of cheese factories have been handicapped from the very beginning because of lack of foresight in planning the factory or choosing its site. Failure to give consideration to any one of the following points can be very costly:

1. The supply of milk within a relatively short radius should be such as to warrant the undertaking.
2. Disposal of sewage and factory wastes must be provided for.
3. Smoke or factory odours should not constitute a nuisance for nearby residences.
4. The water supply should be plentiful and preferably cold and free from scale-forming properties.
5. The factory building should be well constructed and warm enough to allow for winter cheesemaking.

With regard to the type of building, it is worthwhile to note that in most dairy districts the trend is towards larger plants with greater flexibility in manufacturing operations. Where a new plant is being considered, it is often possible to make provision for these features without much additional cost. The advantages of a combined cheese factory and creamery are well known, and for that reason the floor plan adopted should allow for the installation of creamery equipment. In addition, it should be possible to use the factory as a fluid milk or condensary receiving station, or as a casein plant.

A spacious, well-lighted make-room is a great aid in maintaining satisfactory plant sanitation. Employee morale is also benefitted where working conditions are convenient and not congested. Careful planning to utilize fully all floor (and to some extent wall and ceiling) space is necessary to accomplish this without entailing excessive building costs. The floor plan shown in Fig. 2 illustrates some features along these lines, especially the ease with which capacity can be increased.

In 1939 the Dominion Department of Agriculture began giving financial assistance in the construction of new cheese factories, providing certain conditions were met. These are described in *The Cheese and Cheese Factory Improvement Act* and anyone contemplating building a factory should be familiar with it.

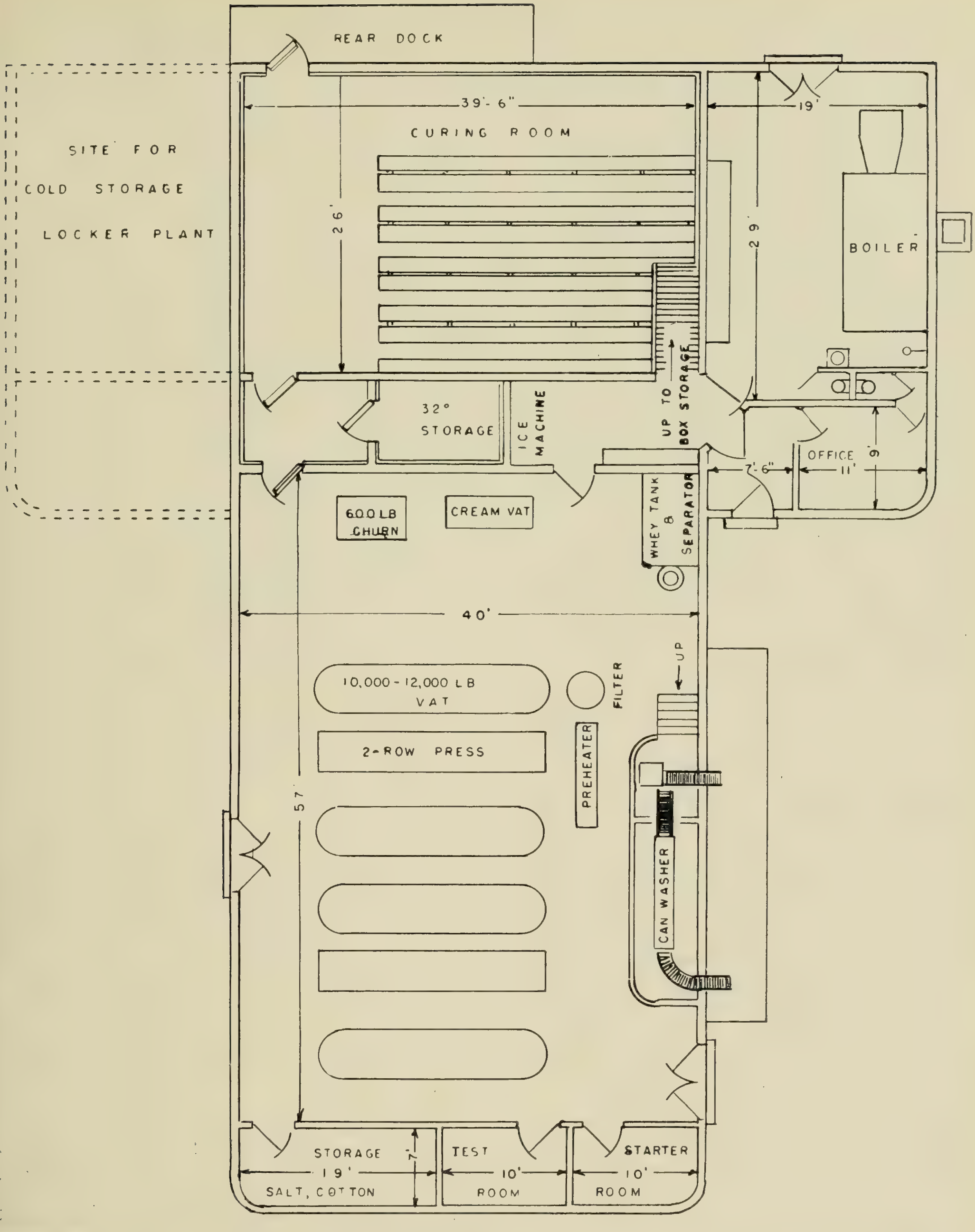

FIG. 2 The choice of a floor plan that will allow for a certain amount of expansion without excessive cost, should be aimed at whenever new construction or alteration is contemplated. The possibility of providing cold storage locker plant service for the community should also be considered.

In the plan illustrated, a capacity of 40,000-50,000 pounds is contemplated, although, by the installation of larger vats, capacity could be readily increased. Creamery equipment might be installed where the small churn is shown and a butter storage provided by utilizing some of the proposed locker storage space. Short, straight lines for milk, whey, steam and ammonia should contribute to reduced costs in the plan illustrated. Another feature is the fact that traffic at the right hand end of the vats will not interfere with the work of receiving milk or removing whey. Access to the curing room through the rear door is also an advantage.

In Ontario where the construction of a new factory is planned to replace two or more factories already in existence, assistance is also available in the form of loans under *The Consolidated Cheese Factories Act.* This assistance, together with the grants available under the *Cheese and Cheese Factory Improvement Act* is a means of reducing the original capital investment required to a considerable degree. Advantage of this assistance should be taken wherever it is possible to do so.

Many cheesemakers are plagued by a lack of sufficient curing room space. Regulations made under *The Ontario Dairy Products Act* require that factories be equipped with curing room shelf-space for eight days' cheese. This has sometimes been achieved at the expense of crowding out other facilities which should be present in the curing room. To receive assistance under the terms of *The Cheese and Cheese Factory Improvement Act,* shelf-space for 17 days' cheese during the period of peak production must be provided and the room must be insulated or refrigerated.

Lack of sufficient capacity in whey tanks, boilers, pumps, refrigerating equipment, etc., can be just as inconvenient as cramped working quarters. In many cases the quality of dairy products has been adversely affected because the factory equipment was overloaded during the seasons of heavy production.

THE MILK SUPPLY

Producing Milk for Cheesemaking

Dairy farmers who supply milk to cheese factories have the advantage that the quantity of milk they may sell is limited only by their ability to produce with no necessity to maintain a uniform flow. This has resulted in a tendency for cheese factory milk supplies to fluctuate greatly during the year, the peak coming during the season of cheap summer production. Summer milk ordinarily possesses superior flavour qualities compared to winter milk, a fact which is in turn reflected in market preferences for "grass" as compared to "fodder" cheese.

Maintaining a clean flavour and good bacteriological quality during the pasture season would present no difficulties if it did not coincide with hot weather and the period of haying and harvest. Quite frequently milk quality suffers at such a time and cheesemakers have become accustomed to recognize five main sources of defects. These are:

1. Neglect of the milking machine;
2. Improper care of pails, strainers and cans;
3. Failure to cool the night's milk;
4. Mastitis;
5. Excessive sediment content.

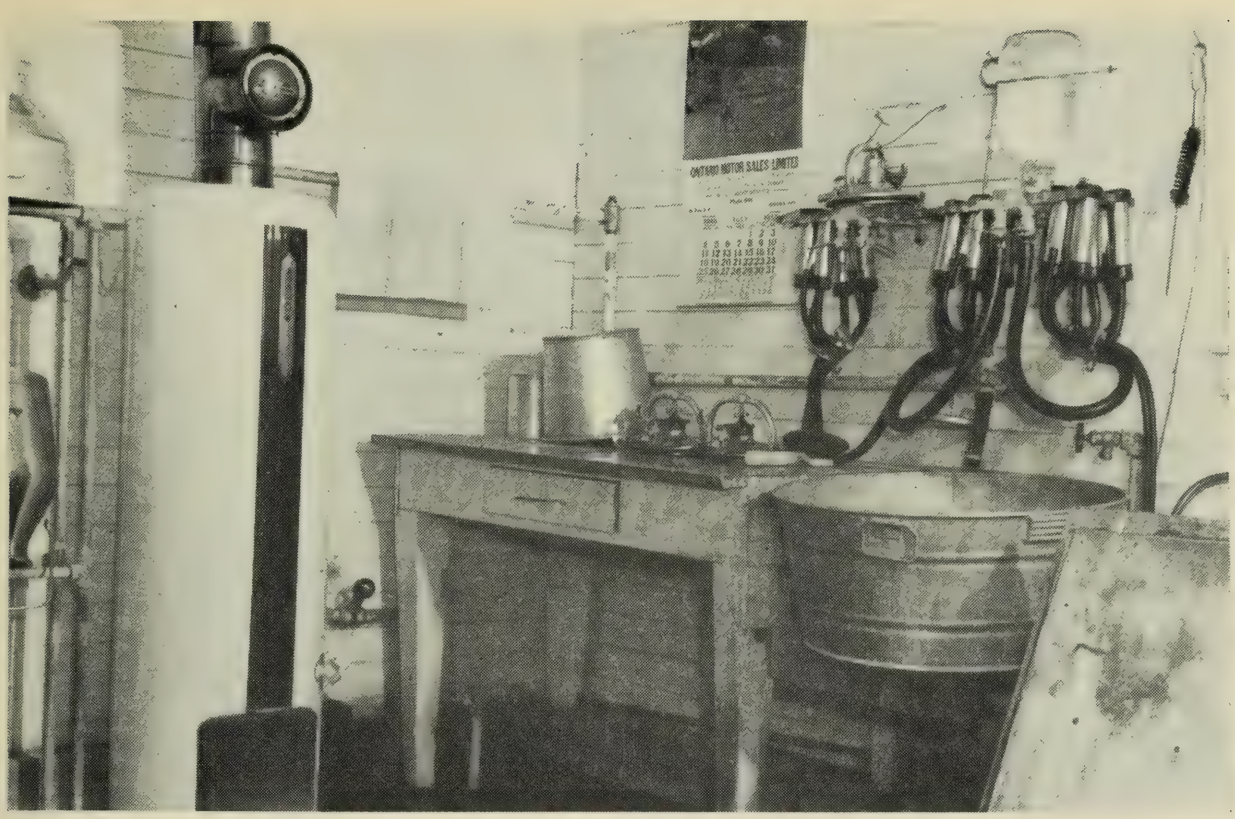

FIG. 3 On a great many farms the work of washing the milking machine and the other dairy utensils could be done much more easily if proper facilities for the job were available. Suitable racks for holding milker pails, strainers and cans, a solution rack for the tubes and teat cups, a sink and table for washing and a supply of cleanser and hot water are all necessary if a thorough job of caring for this equipment is to be done.

In addition it is sometimes necessary to reject milk because of strong feed, weed or pasture flavours. Milk tainted with turnips or leeks is particularly objectionable since small amounts of it will reduce the flavour score of a whole vat of cheese.

Most cheesemakers find it to their advantage to take every possible opportunity to keep their patrons abreast of the latest sanitary methods of milk production. Quite frequently the production of poor quality milk is directly traceable to a lack of knowledge of proper methods. This is often the case among producers who have had limited experience with milking machines. In such cases it is well worthwhile for the cheesemaker to spend an hour or two demonstrating proper sanitary methods.

Pails, strainers, cans, etc., require the same careful cleaning for cheese milk production as for any other type of dairying. The use of good utensils, properly cleaned after every milking, will confer a great favour on the cheesemaker. Cooling cheese milk is usually only necessary in the case of the night's milk. A low temperature is not ordinarily required, 60 deg. F or lower being satisfactory. Failure to attend to this point, however, frequently results in gassy or high acid milk. Air cooling is particularly ineffective especially during the late spring, summer and early fall. Placing the cans in cold water up to the level to which they are filled with milk should be a regular practice during this period of the year regardless of the air temperature. Stirring of the milk is advisable to hasten cooling if 30 gallon cans are used.

Aerating milk is no longer considered a desirable practice. Clean, properly produced milk is more likely to absorb odours than lose them where this is done. As soon as filled, the cans should be tightly covered to prevent the entrance of dust or insects.

Mastitis milk, even when present in the vat in small proportions, can often "play hob" with cheesemaking operations and the quality of the cheese. Cases of the disease in the **acute** form are readily noted but **chronic** mastitis often goes undetected since the appearance of the milk is normal. The sale of milk from cows known to be chronically "wrong in the udder" is a real disservice to any cheese factory.

Sediment in cheese factory milk supplies is another defect which must be restricted to a minimum. The regular use of single-service filter strainers appears to be the only system of filtering which is entirely satisfactory.

Recent evidence appears to indicate that cheese milk may require special care while being transported to the factory. Experiments carried out by the Division of Dairy Research at Ottawa show that agitating warm milk is a cause of rancid and unclean flavours in cheese. For this reason the shipment of partially filled cans should, wherever possible, be avoided.

Grading the Incoming Milk

In order to keep the sanitary quality of the milk at as high a level as possible the cheesemaker may take advantage of certain quality tests. The test most frequently relied upon is that of odour, and a cheesemaker without a keen, well-trained sense of smell is at a serious disadvantage. Tests for acidity, methylene blue reduction time, curd character (Wisconsin curd test), and sediment can be used to advantage as well. The acidity is often used as a platform test, it being illegal in Ontario to accept milk for cheesemaking if the acidity is over 0.22 per cent. The methylene blue test is of value in checking up on farm sanitation and cooling while the Wisconsin curd test is used to track down undesirable fermentations, the sources of which are sometimes difficult to determine. An average methylene blue reduction time of three hours should provide fairly good cheese milk. Where the reduction time is less than one hour it is evidence that production methods are unsatisfactory. If either the methylene blue or resazurin test is used regularly the cheesemaker is in a much better position to warn delinquent patrons and to head off trouble in the early stages.

Regularity should be a feature of all quality testing, and especially so of sediment control. If this test is carried out only two or three times each year it has little salutary effect.

Reporting the results of quality tests is no great difficulty if all patrons deliver their own milk as is often the case at smaller factories. In the case of the large factory much of the value of such a program will not be realized if the results are not reported effectively and promptly to the producers. This can best be done by utilizing simple report forms, or in the case of sediment, returning the sediment disc.

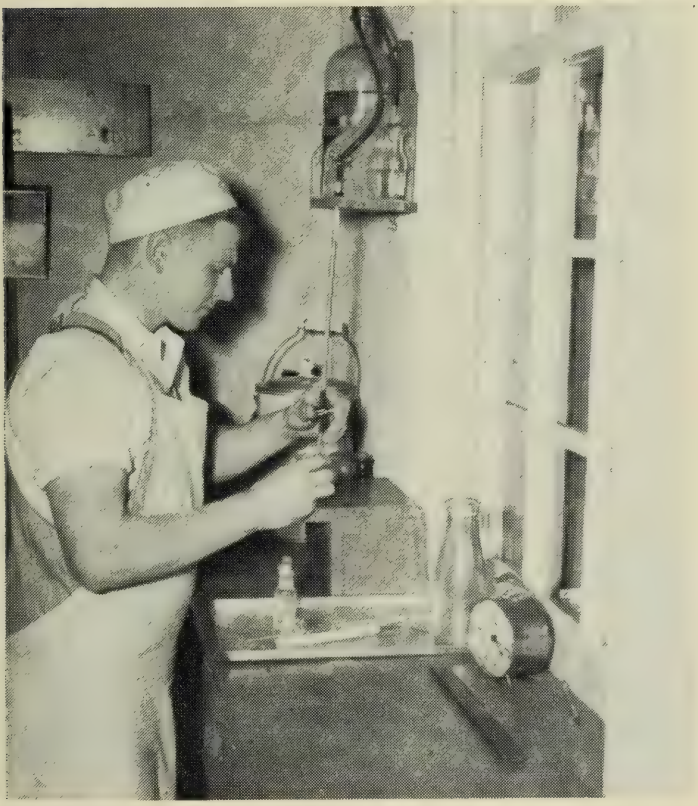

FIG. 4 The acidimeter has become an indispensable tool in the modern cheese factory. Dependable results can only be secured however, if the alkali and indicator solutions are of proper strength.

The system of testing composite samples for butter fat and of making returns to cheese milk producers has lagged behind other branches of the industry. Testing and paying for milk at semi-monthly rather than monthly intervals would prove more convenient for most factory patrons and it is hoped that more factories will be able to adopt this policy in the future. In some plants facilities for refrigerating the composite samples during the warmer months are lacking, with the result that the accuracy of the tests is reduced. Except during the weighing-in period these should be stored at a temperature of 60 deg. F or lower.

Filtering

Extraneous or foreign matter in cheese is highly undesirable and rigid control of it should be the aim of every cheese manufacturer. This can best be accomplished by insisting on the use of efficient filters on the farm and by preventing subsequent contamination during processing. The need for more efficient equipment for filtering the incoming milk at the factory has long been recognized, but only recently have filters been designed to fill this need. The cheesecloth strainer, unless of several thicknesses and changed frequently, is seldom an efficient means of filtration.

Filtering the incoming milk can be greatly facilitated if the milk is first tempered to 80-86° F by passage through a preheater. This equipment, while expensive, soon pays for itself since it is a much more economical method of heating milk than in the vat. Factories with good records for freedom from extraneous matter in their cheese credit much of their success to improved systems of handling the incoming milk. The use of a cotton quilt batt between two layers of factory cotton, and supported by a ¼-inch mesh screen works well as a filter for this preheated milk. If a filter area of about 12 square feet is provided, the milk should pass through rapidly enough so as not to delay the receiving operations.

An alternative and even more efficient method of removing dirt from milk is the use of the clarifier. Recent experiments indicate the practicability of this machine for the medium or large plant.

Factory Responsibility for Milk Cans

At the present time very few cheese factories in Ontario are equipped with can washers with the result that this task must be done on the farm by the milk producer, or as is frequently the case, by his wife. If careful methods are used in this operation, farm washing is usually quite satisfactory. The cheese factory, however, can do a great deal to make this task easier and at the same time ensure a higher quality in its milk supply by taking the following steps:

1. Inspect all cans at regular intervals for such defects as pitting, open seams, leaks, deposits of milk stone, or unsatisfactory washing.

2. Insist upon the replacement or repair of any cans not in good mechanical condition. Retinning is frequently a worthwhile means of extending the life of milk cans.

3. At weekly intervals, particularly during hot weather, rinse out and sterilize by steaming all cans used in the delivery of milk to the factory.

Producers who do not fill their cans with whey should have their cans rinsed and sterilized daily.

4. Ensure that the whey going into the cans be at a temperature of 150-160° F.

Carrying out the above program involves considerable expense in that steam requirements are increased. This expense however, is not great when compared to the benefits which invariably accrue from such a program in the way of higher scoring cheese. Instituting a plan of this type should be the first step for factories wishing to correct the causes of cheese being graded down for flavour or colour defects.

The can steamer aids greatly in weeding out cans which are unsatisfactory due to breaks or open seams. Once the can is well heated over the steamer these crevices are much more readily detected than is otherwise the case. If such cans are immediately sent to the tin-smith for repair a real favour will be done the cheese factory since it is in such defective cans that some types of spore-forming bacteria are introduced into the milk supply.

The use of hot, mildly acid whey is an additional safeguard insofar as can sanitation is concerned. The temperature recommended above is an effective means of destroying almost all the organisms which may remain in the cans after the milk is dumped. Any which do withstand this treatment are not likely to cause serious damage to milk which may later be put in the cans. The milk producer should, of course, make certain that the whey is removed from the cans as soon as it is returned to the farm and also that the cans are washed immediately after the whey is dumped.

STARTER FOR CHEDDAR CHEESEMAKING

The first step in cheesemaking after weighing-in the milk is the addition of the starter to the vat. Special care taken in the preparation of the starter will be well repaid in better working curds and improved quality cheese. The starter's purpose is to convert the milk sugar to lactic acid, starter being an actively growing culture of lactic acid bacteria. Millions of these organisms are introduced into the milk when the starter is added to the vat. They grow by dividing across the centre, forming short chains of spherical bacteria. The lactic acid formed as a result of their growth aids in the manufacturing process as well as in preserving the cheese.

Equipment Required

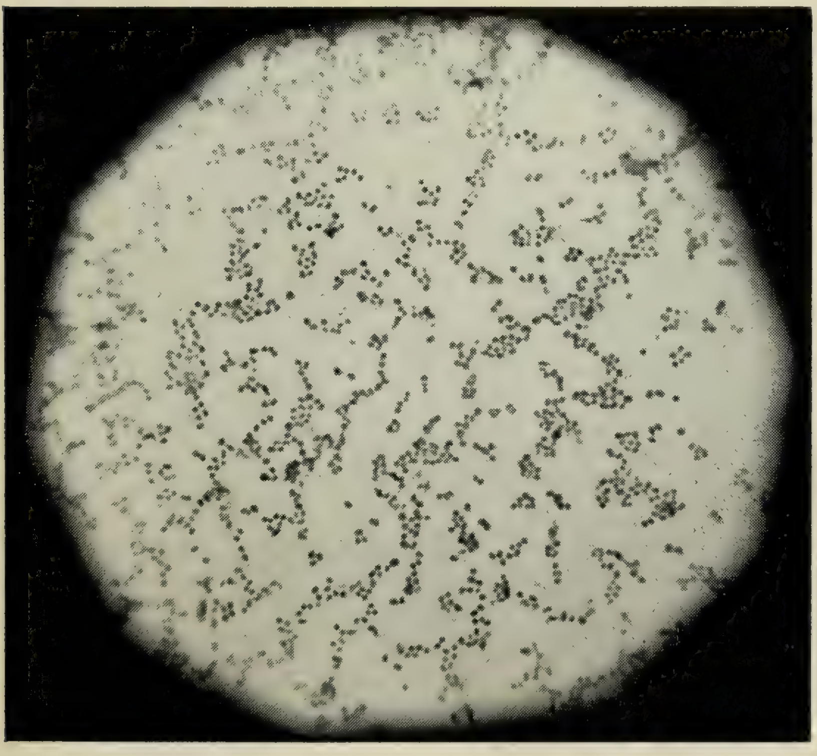

FIG. 5 Photomicrograph of a lactic starter growing in milk, enlarged about 1,000 times.

The equipment necessary for starter making need not be elaborate or expensive, but it should be maintained in good condition. Well-tinned "shot-gun" cans fitted with over-lapping lids are satisfactory containers in which to make the bulk starter. A well-tinned stirring rod should also be provided. Carrying a separate mother or seed-starter is highly recommended and this can be done most conveniently in quart milk bottles. A rectangular tank of rot-resistant wood fitted with steam and cold water connections is widely used as a means of heating and holding the cans of milk. The tank should be fitted with a close-fitting cover. In addition, one or two inches of cork insulation should be provided if there is difficulty in maintaining the proper temperatures during the incubation period. The noise resulting from heating the tank with direct steam will be much less if the line is fitted with a silencer. A "Hartford" connection is also a safeguard on this line. In order to hold the bottles of mother-starter at the proper level in the tank, a copper or Monel metal basket is advised. Many of these details are shown in Fig. 6.

The use of two bottle-caps and a parchment hood as a closure for each of the quart mother-starter bottles has proven very satisfactory. Butter wraps held in place with elastic bands are very convenient as hoods.

Locating the starter tank as far as possible from sources of whey contamination is a wise precaution, particularly the whey separator. A separate room for starter making is a worthwhile investment.

Selecting and Pasteurizing Starter Milk

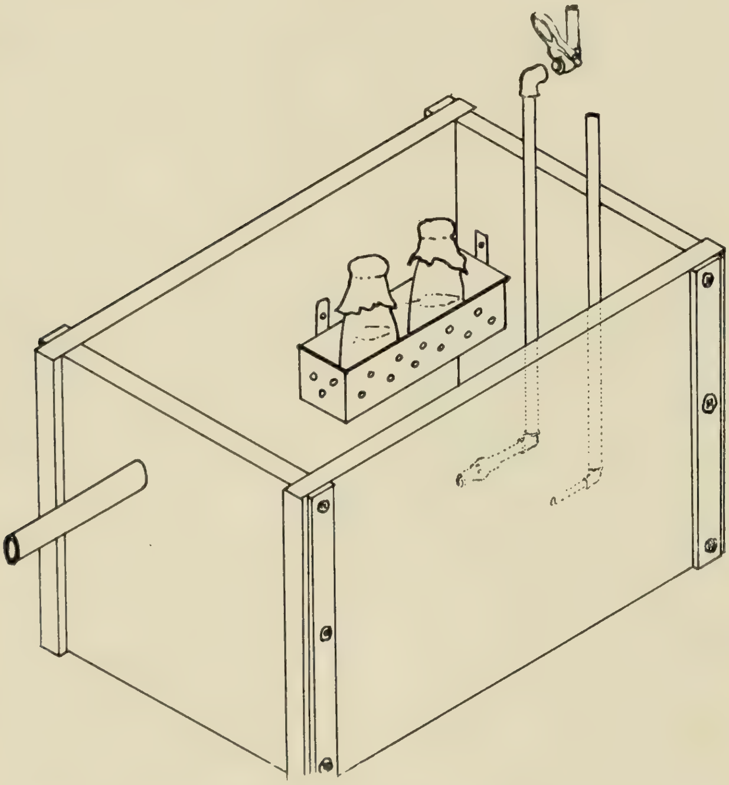

FIG. 6 Outline drawing of starter tank of wood construction showing steam and cold water connections and metal receptacles for mother-starter bottles.

Particular attention must be given to the selection of this milk as it should be of excellent sanitary quality. Milk of abnormal composition due to mastitis or milk which is much above or below the average in total solids content should not be used.

Extremely thorough pasteurization is necessary, a temperature of 185 to 190 deg. F for 45 minutes being the minimum. During the heating and holding period the cans should be stirred two or three times and it is advisable to swirl the bottles also. At the end of this period the milk is cooled to 70 deg. F for seeding and incubation.

Establishing and Carrying a Mother-Starter

Maintaining a mother-starter in quart bottles separate from the bulk starter has many advantages. (1) It is possible by this means to carry two or three different starters without much extra work. (2) Day to day transfers can be done with less danger of contamination. (3) Signs of starter failure can usually be detected earlier with the result that losses from slow curds may be avoided.

Seed material for establishing a mother-starter is obtainable from several dairy laboratories and may come either in powder or liquid form. In case the starter is in powder form when received, the directions accompanying it should be followed carefully. In Ontario, lactic starters in the liquid form are available free from the Dairy Division of the Kemptville Agricultural School, Kemptville, or at a price of 25 cents each from the Bacteriology Department, O. A. C., Guelph. If one of these is being used it should be transferred immediately to a quart bottle, half-filled with milk that has been previouly pasteurized in the bottle as described above. After holding for 15 or 18 hours at 70 deg. F, the milk will be firmly coagulated. The mother-starter thus established should be transferred daily using half-filled bottles of the specially pasteurized milk as the medium. In making the daily transfer, the coagulated mother-starter should have the top one or two inches poured off and be shaken up until smooth and creamy. Then, taking every care to avoid contamination during the operation, 10 or 12 drops should be poured over into the bottle of "sterile" milk. The mother-starter remaining in the bottle is then used to seed the cans of milk that will be the bulk starter the following morning. Transferring the mother-starter and seeding the milk is usually done between 4 and 5 p.m., so that the bulk starter will perform most efficiently the following morning.

It is a good practice to carry two or more mother cultures. If the starter in use gives evidence of lacking vitality or otherwise being defective, it is then a simple matter to switch to another starter.

Seeding the Milk for Bulk Starter

The rod used for stirring the milk in the cans while it was being pasteurized should be left there until time to introduce the mother-starter. With a little practice, one soon learns to pour out an amount of mother-starter onto the dish of the stirring rod that will produce a nice coagulation in the bulk starter by the following morning. Generally about two fluid ounces per 50 pounds of milk will work well. Both water and milk in the starter tank should be about 70 deg. F at this time. Immediately after the starter is "set," the water in the tank should be brought to 70 deg. F, the steam line disconnected and the tank covered. Sometimes temperatures one or two degrees above or below 70 are used if there is a tendency for the tank to cool off or warm up during the night.

On the following morning the bottles of mother-starter should be examined and, if nicely coagulated, set away in a cool place (40-50 deg. F) until needed later in the day. If the bulk starter is not to be used within an hour or two it also should be chilled. Otherwise it should be first skimmed with a scalded stirring rod and then broken up by vigorous stirring. If there is any evidence that the starter is lumpy it should be strained before being added to the vat.

Characteristics of a Good Starter

Flavour and aroma of the right type are the best indications of good quality in a starter. A clean, pleasant, acid flavour, free from excessive sharpness, is desired. The aroma should be of the same character although a high diacetyl content is not favoured for cheese starters. If these qualities are not present or the flavour is otherwise defective, the starter should be replaced at once.

The body and texture of the starter should be inspected both before and after "breaking." Wheying-off, poor coagulation, and slits and breaks in the curd are all undesirable features. After being broken the starter should be fairly thick, creamy and completely free from lumps.

Acidity is another index of starter quality. Values between 0.70 and 0.90 per cent are acceptable and associated with high vitality. Acidities outside this range would indicate that the starter was either abnormal or else under- or over-ripe.

Avoiding Starter Troubles

Even partial failure of the starter can be an aggravating experience. Lack of vitality is usually traceable to one of three causes:

(1) Contamination by other micro-organisms;

(2) Contamination by bacteriophage;

(3) Exposure of the starter organisms to excess acidity.

Chances of contamination by foreign micro-organisms are reduced a great deal when the methods described above are employed. The strictest sanitary rules must be followed in scrubbing and sterilizing bottles and cans while the mother-starter should only be transferred in a room free from dust, flies, spray, etc.

Bacteriophage or "phage" is a highly specific type of infection which frequently attacks starters and causes a sudden slowing down in their ability to produce acid. Dried whey foam has been found to be a common source of this infection although it may also be present on factory equipment or in the milk supply. In New Zealand where trouble of this type is of more consequence because of the use of pasteurized milk for cheese-making, authorities have advocated the use of a separate building for carrying the starter. Where trouble from 'phage occurs, a new starter from a different dairy laboratory should be secured and used in place of the strain of the starter which was attacked.

Most successful starter makers follow the practice of obtaining a new seed starter regularly. By doing so they have a fresh, dependable source of material from which to propagate new mother-starters. This is a more reliable method of securing an active starter than by being dependent upon a neighbouring factory or dairy.

CURD-MAKING

Rate and Time at which to Add Starter

Starter is used at rates varying from 0.5 to 1.5 per cent in most Ontario factories. For many years the use of more than 0.5 per cent was the exception rather than the rule, although lately there appears to be a tendency towards the use of more starter. This has the effect of speeding up cheesemaking operations and will cause no harm unless overdone. The use of too much starter however, results in curds which work too fast and develop too much acidity before they can be properly firmed in the whey. Weak-bodied cheese, pre-disposed to texture and colour defects are often the result.

Enough starter should be used to initiate acid development without an excessive delay. Milk produced under certain conditions and especially during the winter months is often slow in the early stages and the use of higher rates of starter is common under such circumstances. Well-cooled, machine-drawn milk also usually requires extra starter to move. When cold milk is being received it is advisable to warm it to 65-75 deg. F before adding the starter.

The length of time that the milk is held between adding the starter and rennetting is known as the ripening period. During this period the starter organisms begin multiplying and the acidity begins to rise. The length of time allowed for ripening may vary from a few minutes, with high acid, fast-working summer milk, to one hour and a half or more for milk of the type described above. This is usually not lost time as the vat may be filling throughout this period.

The Marschall Rennet Test is an accurate method of determining the degree of ripeness, although it is not as widely used now as formerly. The Pink Test, based on the speed with which resazurin in milk is reduced to the pink state, is a simple, accurate method of knowing when the vat is ready for rennetting. Another good rule to follow in governing ripening is to allow sufficient time for the acidity to show a definite increase. For example if the milk immediately after the starter is added tested 0.17 per cent acidity, the vat should be held until an acidity of say 0.18 per cent is obtained. One soon gains experience along this line and learns how much "grip" to allow.

If it is necessary to speed up the process of cheesemaking, it is preferable to do so by allowing a longer ripening period than by increasing the rate of starter. The use of a lot of starter and a short ripening period tends to result in high moisture curds which work too rapidly after the whey is removed.

Other Details of Ripening

Agitation and proper temperature are two details of ripening which should receive attention. If just enough stirring is given to maintain a uniform temperature and prevent the cream rising, satisfactory results should be secured. Excessive agitation of warm milk is very undesirable. A temperature of about 76 deg. F is recommended for ripening although a higher temperature will do no great harm if more rapid development of acidity is thought necessary.

Adding Colour and Rennet Extract

When the acidity of the milk approaches the rennetting point the temperature should be brought to 86 deg. F and the total weight of milk in the vat ascertained. From this weight the amount of colour and rennet extract to be used should be calculated. When cheese colour is used it is usually added at a rate of 1.0 to 1.25 fluid ounces per 1000 pounds of milk. This rate must be varied slightly to secure uniform colour in the cheese and will depend upon such factors as season of year, intensity of colour desired, strength of colour, etc. Lack of uniformity in colour from one vat to another should be carefully avoided. The colour will be stirred in more rapidly if it is diluted three or four times with warm (not hot) water. A period of three or four minutes should be allowed for complete distribution of this material.

The rennet extract may then be added, the usual rate being about three fluid ounces per 1000 pounds of milk. This rate should be adjusted so that a satisfactory coagulation will be secured in about 25 minutes. The required amount of rennet should be carefully measured out, diluted with about 20 times its own volume of cold water, and distributed throughout the length of the vat while the agitator paddles are running at full speed. Stirring should be applied for three minutes although it is good practice to reduce the speed of the paddles for the latter part of this period. Any churned fat floating on the surface of the vat should be skimmed off immediately after the paddles are removed.

Coagulation

Anything which interferes with satisfactory coagulation will result in less efficient retention of the fat and other solids in the cheesemaking process. Such factors as improper temperature of the milk, weak or insufficient rennet, improper rennetting acidity, etc., will cause excessive

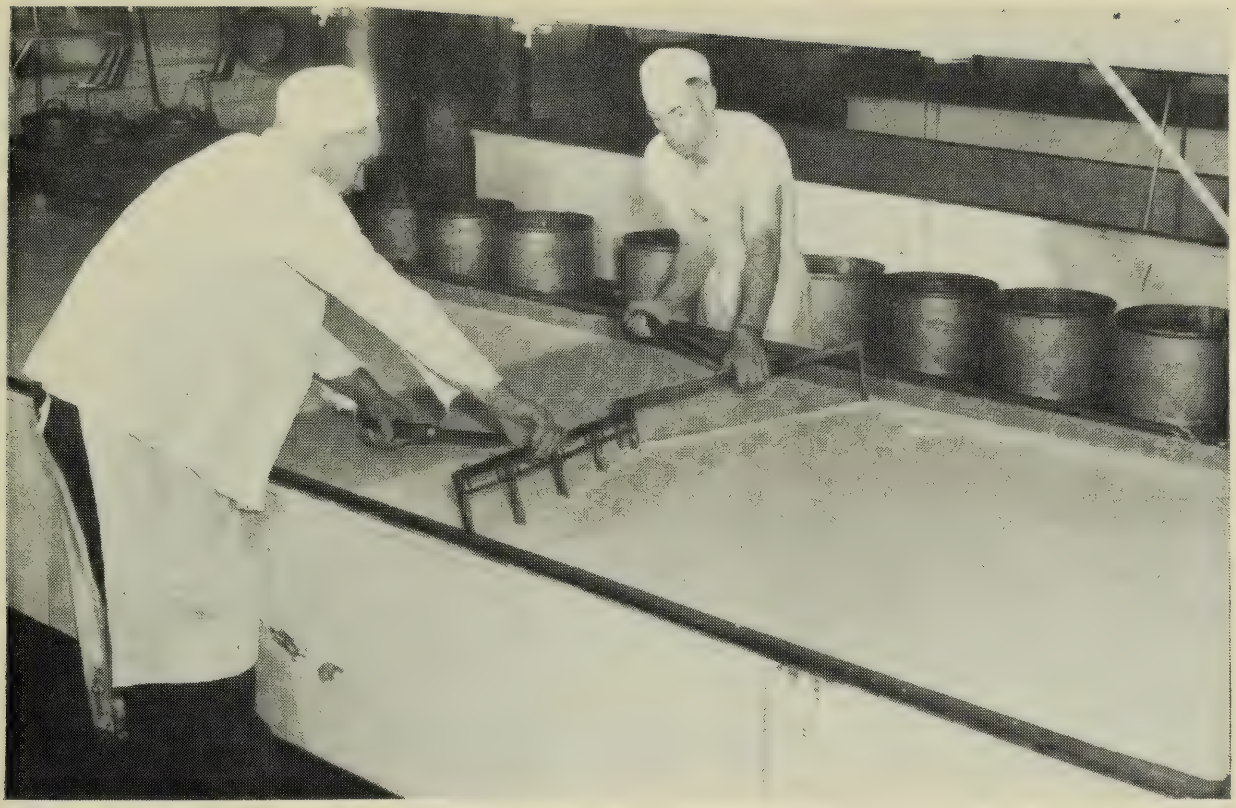

FIG. 7 The above illustration shows a pair of wide curd knives being used in a full vat at the cutting stage. Note that the knives are angled slightly in a manner which prevents any curd being left uncut. After traversing the length of the vat the positions of the knives are reversed and the second cut is made, thus transforming the curd into long strings. The vat is finally cut crosswise with the vertical knife to complete the cutting. Inserting knives at the ends of the vat should be done with care in order to avoid hashing up the curd.

losses of fat and casein. During this period the vat should not be jiggled or jarred and the surface of the curd should be protected from cold drafts. Towards the end of the coagulation period the curd should be examined for firmness by inserting a finger into the curd and slowly raising it. When the curd breaks cleanly and the whey escapes freely from the broken surfaces, the curd is ready to be cut. Losses in the whey will be increased if the curd is cut either before or after the proper degree of firmness is reached.

If there is any possibility that the water used for diluting the rennet is impure, it should be boiled and cooled before being used.

Cutting the Curd

The purpose of cutting is to reduce the curd to small, uniform sized cubes. This can best be done by the use of curd knives strung with wires three-sixteenths or one-quarter inches apart. It is preferable to have knives that are only just one-half the width of the vat. Fig. 7 illustrates the use of a pair of such knives. After being drawn throughout the length of the vat, their positions are reversed and they are drawn back again. This converts the curd to long strips. The vat is then cut crosswise using the vertical knife which cuts these strips into cubes. Careless cutting, more than anything else, can increase mechanical losses in cheesemaking. The manner in which the knives are inserted and removed from the curd should be such as to prevent the production of fine curd particles insofar as possible. Using knives with missing wires is poor practice.

Cooking the Curd

As soon as the curd is cut the cubes begin to contract and in doing so expel whey. The coagulation and shrinking of the curd is caused by the rennet extract but is speeded up as the acidity increases. Further contraction of the curd cubes results from the application of heat and, by the careful use of this agency, both the texture of the curd and the rate of acid development can be controlled. As the curd shrinks much of the water and any of the milk constituents in true solution are expelled and become part of the whey. Over 90 per cent of the fat and about 95 per cent of the casein are retained in the curd along with the larger part of the lactic acid bacteria population and the calcium and phosphorus of the milk. The "cooking" process consists of raising the temperature of the vat from 86 to 100-102 deg. F and holding the curd at this temperature until the acidity of the whey reaches the point where it may be run off. There are several details of this operation which must receive careful attention in order to avoid damaging the final texture qualities.

Immediately after cutting, the curd sticking to the sides and bottom of the vat should be scraped free and an acidity test made on the whey. The agitation given the curd during this period should be very gentle in order to avoid shattering the curd cubes which are quite fragile at this stage. Providing the acidity appears to be coming along normally, heating may begin ten or twelve minutes after cutting is finished. However, if the acidity of the whey is either abnormally low (say 0.11 per cent) or abnormally high (0.14), allowance should be made for it either by advancing or delaying the time when heating is begun. In the case of slow curds it is wise to withhold heating until the acidity gives evidence of beginning to increase. The starter organisms multiply more rapidly at this temperature level than at the final cooking temperature.

The temperature should be increased slowly at first and then slightly more rapidly until the final cooking temperature is reached. A fair rule to follow is to try to have the vat up to 92 deg. F about one hour after adding the rennet.

Temperatures above 102 deg. F are seldom advisable except as a means of controlling "fast" curds. This is especially true where the fat content of the milk is low or subject to seasonal variations. A reliable thermometer should be used here.

During cool weather it is sometimes necessary to introduce a small amount of steam once or twice during the holding period to maintain the vat at the proper temperature. It is particularly important that the curd does not cool down just before removing the whey.

Many factories follow the practice of removing about half the whey from the vat before the final running acidity is reached. This facilitates handling the whey in a large factory and also hastens the development of acidity. This may be done about two hours after adding the rennet and with a whey acidity of about 0.15 per cent. Agitation should be continuous up until this time. However, after the whey is "run down" some cheesemakers prefer to rake the vat by hand at intervals until ready for running.

Running the Whey

During the next 30 or 40 minutes the curd will become considerably firmer. A handful of curd squeezed in the hand will display a springy character and should fall apart when released. This increase in firmness will coincide with increasing acidity in the whey and the two properties should be watched closely so that the whey may be removed at the proper time. Proper cooking and controlled acid development are both necessary to secure a curd which has the desired firmness together with right acidity.

With good management the whey acidity will reach a value of between 0.175 to 0.195 per cent about 2½ to 3 hours after rennetting. The value adopted as the final running acidity will depend to some extent upon such factors as the fat content of the milk, rate of starter, season, etc. When this acidity is reached the curd should be allowed to settle after which it should be pushed away from the lower end of the vat. The remaining whey is then drained off as quickly as possible. When most of the curd is exposed the curd should be ditched along each side of the vat starting at the upper end. A minute or two later stirring can be started at the lower end, drawing the curd to each side and leaving a clean channel down the middle of the vat.

Stirring Out the Whey

The curd is next given a series of stirrings to allow the whey to drain freely. These should be continued at intervals until the moisture content is reduced to a point where firm bodied cheese will be secured. If the time between stirrings is too long the curd will set solidly and it will be difficult to break up.

Use of Forking Agitators

Many factories have recently become equipped with travelling and forking agitators, thereby largely eliminating the drudgery involved in the hand stirring of curds. Grading records of factories possessing this equipment indicate that the quality of the cheese now being made in these plants is equally as high as prior to the installation of this equipment. In using these agitators the chief point to observe is to avoid allowing the curd to mat together too firmly to be broken up readily by the forks. This can be partially avoided by firming the curd well before running off all the whey, the forks doing a particularly efficient job if allowed to run at low speed with the whey just level with the curd. Also, at the time the whey is draining, the forking can be started in the upper end of the vat, thus preventing the curd becoming matted.

Another point requiring attention is that drainage of the whey during stirring must be promoted by stopping the agitators at intervals and ditching the curd down the centre of the vat. This may have to be done three or four times before the curd is dry enough to pull up along the sides of the vat preparatory to piling. The forks should be started again just as soon as there is danger of the curd matting too firmly.

Cheesemakers using forking agitators for the first time will find it highly advisable to do a thorough job of clearing the curd well away from the lower end of the vat before running the whey off. Failure to do this complicates the use of the forks in stirring out the curd.

Improperly adjusted paddles or forks have, in some cases, prejudiced cheesemakers against this type of equipment. One should be sure that the installation is satisfactory at the outset in changing to agitators of this type.

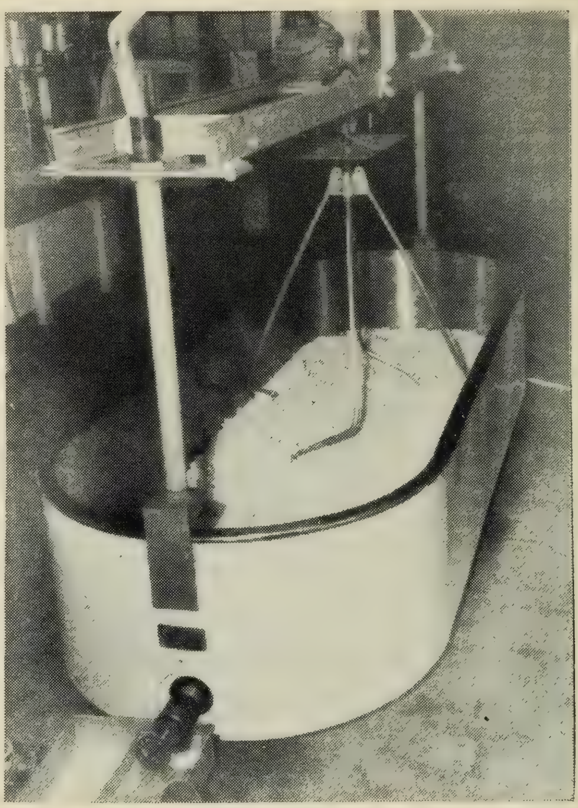

FIG. 8 In stirring out the whey, either by hand or with forking agitators, it is highly important that the curds be kept well broken up right from the start. Stirring should be interrupted at intervals to ditch the curd down the centre of the vat, but it should be resumed again before there is danger of the curd becoming lumpy. The work at this stage of the process is greatly facilitated if the curd in the lower end of the vat is pushed well away from the gate-valve before commencing to run the whey.

Piling the Curd

Methods used for piling and cheddaring curds vary considerably from one district to another. The one suggested below is recommended and is one which is easily followed.

The last time the curd is stirred it should be worked toward the upper end of the vat and left along each side in a mass about five or six inches deep. It is allowed to lie in this position for four or five minutes after which the mass of curd is broken into pieces about ten inches wide, the pieces being turned about three-quarters of the way over and left lapped on one another like furrows of sod. These steps are illustrated in

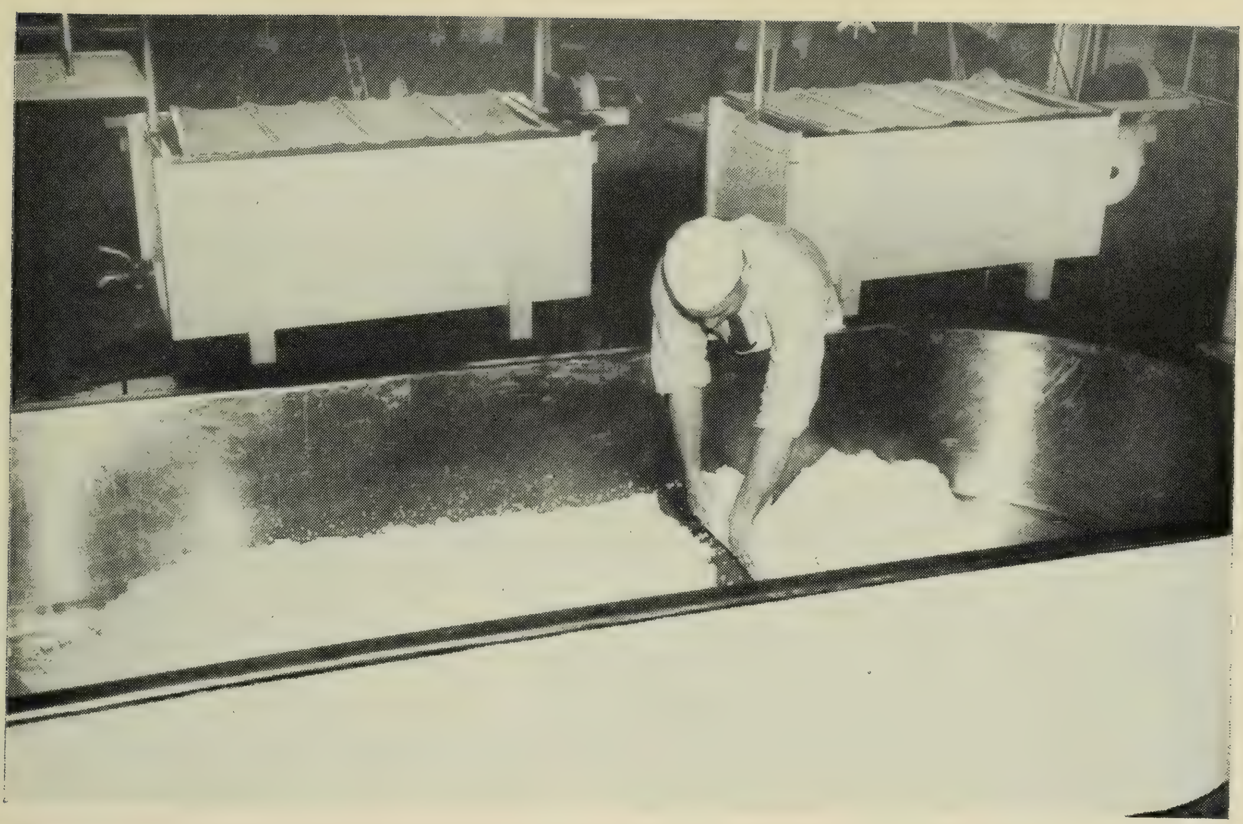

FIG. 9 The method of piling shown in the above illustration has several advantages. After the curd has begun to mat for 4 or 5 minutes, it is broken in this fashion into pieces about 10 inches wide, the pieces then being turned about two-thirds of the way over. This allows matting to begin a few minutes earlier yet at the same time underdrainage is facilitated by the channels made through the mass of curd.

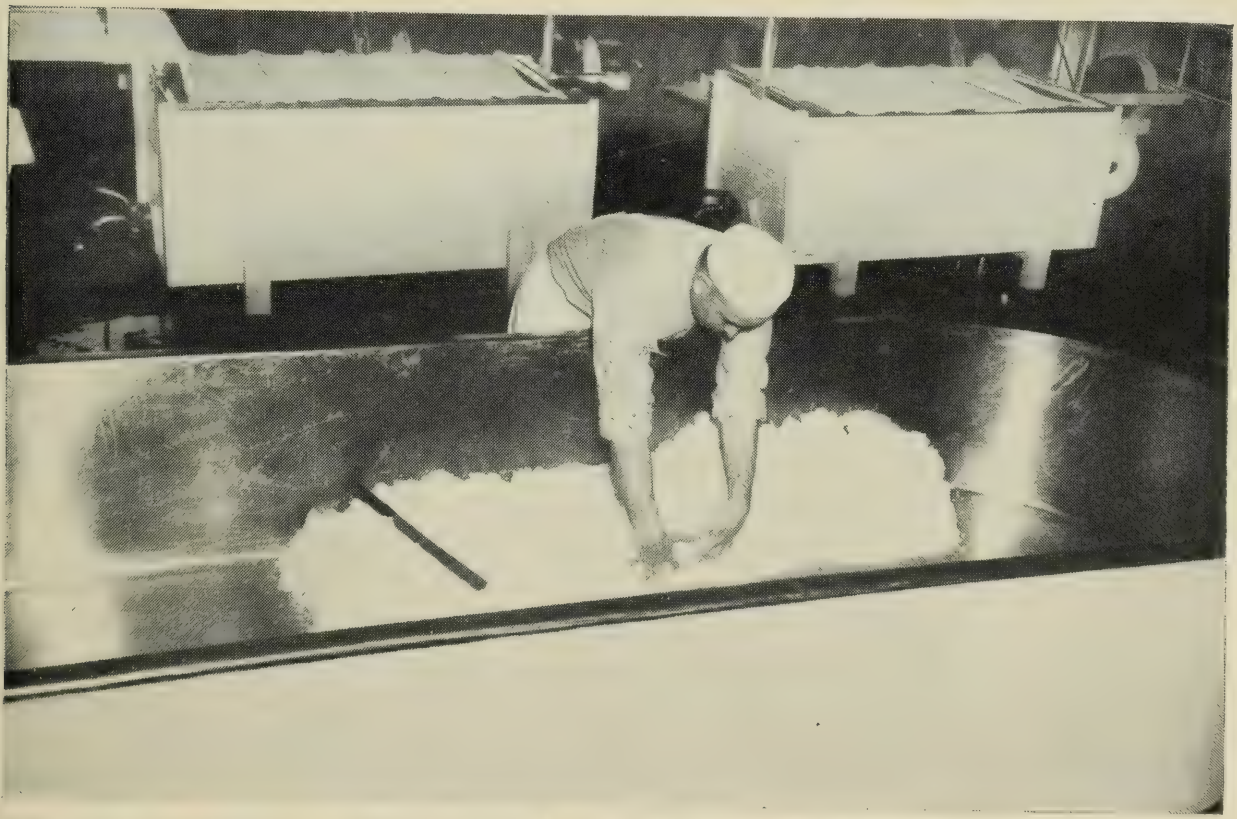

FIG. 10 Subsequent to piling the curd as in Fig. 9 it is a good practice to trim off the rough edges of the mass of curd and turn these upside-down on top of the pile.

Figs. 9 and 10. Then, after smoothing off the rough upper surface, the irregular inner edge of the curd in trimmed off and turned upside down on top. Time spent in doing a neat job of piling and trimming will be repaid by having a curd that is more easily handled during the cheddaring and milling operations. The time allowed from piling to the next operation is usually about 40 minutes.

Cheddaring

The practice of allowing the small curd particles to mat together to form large chunks of curd is peculiar to the Cheddar process and has come to be known as cheddaring. This practice came into vogue during the 1870's and has been of great benefit to the industry in that cheese produced by this method have a close, meat-like texture and better keeping quality. Cheese manufactured without the inclusion of this step tends to be granular and open.

The cheddaring process begins when the curd is piled. If the curd is developing properly, the particles of curd begin fusing together into a dense mass. This action takes place faster in high acid curds held at a high temperature. Too rapid matting is not desired since whey will be retained in the curd and result in a weak-bodied cheese. On the other hand, a curd which tends to be dry and crumbly at this stage will be predisposed to rough texture qualities when made up. It is good practice to reduce the time from piling to first turning for a fast working curd and allow a slightly longer time for a slow working curd to compensate for defects of these types. During periods of warm weather, it will usually be necessary to turn curds more frequently than at other times of the year however.

The matted curd will be ready for cutting and turning after it has stood for about 40 minutes. The curd should be cut into pieces about 8-9 inches wide and these turned upside down and end for end. If the curd appears to contain an excessive amount of moisture, the pieces should be separated slightly from one another to allow drainage to continue. Allow the curds to lie undisturbed for 20 minutes in this position.

On the second turn the pieces of curd should be cut across their centres and piled two deep after which they should lie for ten minutes. On the third turn the pieces may be piled three high, care being taken to alternate the position of each piece of curd on this and successive turnings so that each piece will receive an equivalent period of time in each position in the pile. Successive turnings should be made at ten minute intervals until the curd is ready for milling. During the summer months it is recommended that the curds be piled not more than three or four high until just before milling. During the fall and winter however, deeper piling is usually necessary in order to have the curds "flake out" well and display the desired texture for milling.

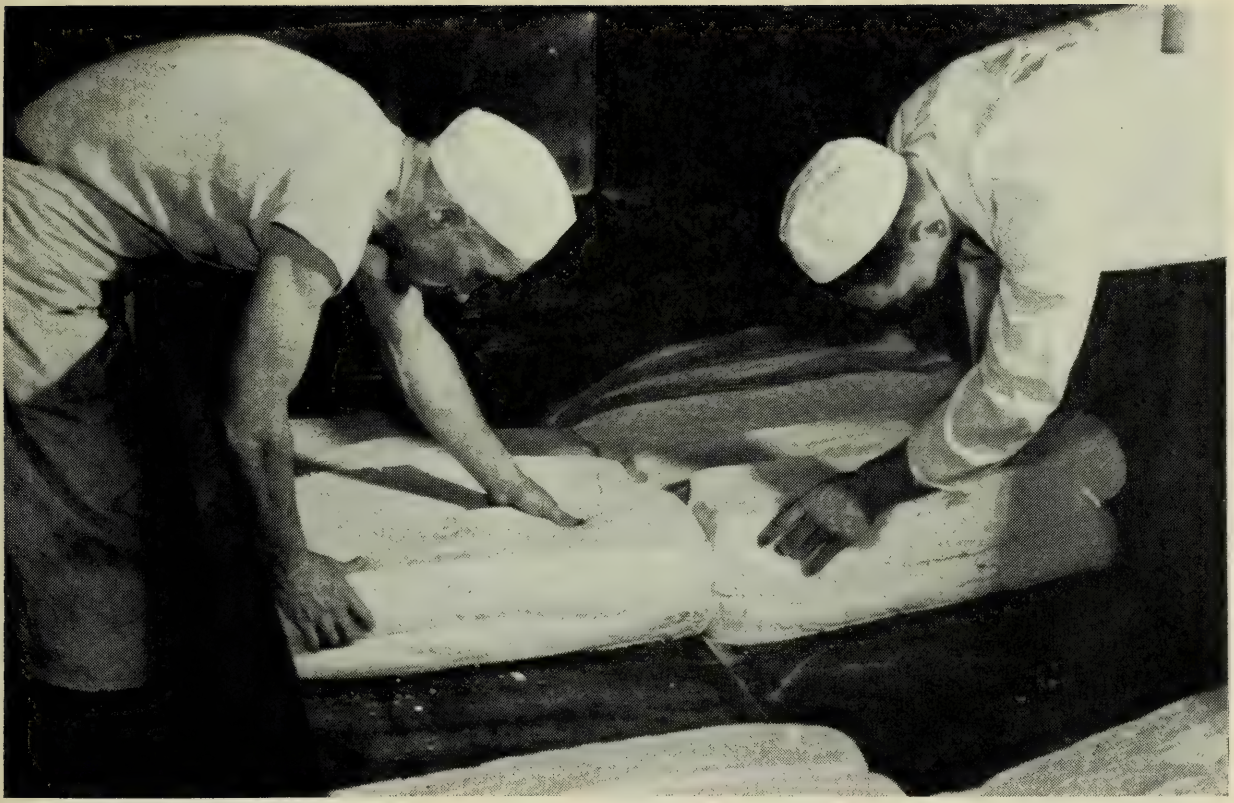

FIG. 11 The cheddaring process is largely responsible for developing the fine texture qualities which are looked for in a good cheese. A sufficient length of time should be allowed at this stage for the curd to become smooth and mellow. An active starter aids greatly in hastening this part of the process.

Except when the curd is being handled, the vat should be kept covered with a vat cover. This helps maintain a uniform temperature, reduces evaporation from the exposed curd surface and prevents the curd becoming contaminated with extraneous matter carried by air currents.

Milling

After the first few turns of the cheddaring process, the curds begin to develop a smooth, velvety surface and a texture like well-cooked lean meat. Some whey will drain from the curd during this period and tests run on it will show that its acidity is increasing rapidly. About 2½ hours after running it will have advanced to 0.85 per cent or more and the curd should be close and well flaked out. When this condition is reached it should be milled. The matted curd should be cut into strips suited to the mill and fed into it in such a way that it will be sliced into even strips about four or five inches long.

Following milling the curd is again stirred thoroughly at intervals of 10 or 15 minutes until the texture is smooth and silky. Stirring or forking at this stage aids greatly in bringing out the best qualities of texture, flavour and colour.

The length of time which the milled curd should be held before it is salted varies considerably at different seasons of the year. If the cheese

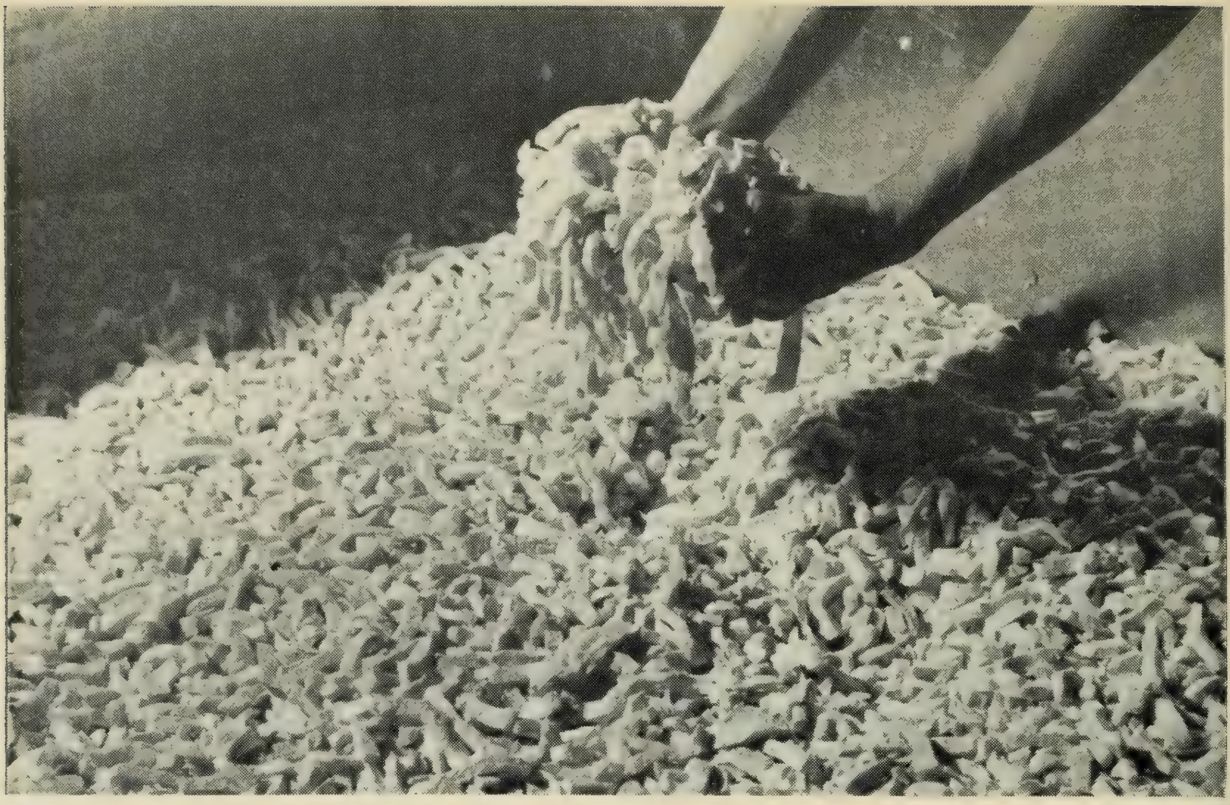

FIG. 12 A careful examination of the freshly milled curd should be made for flavour and texture qualities. Proper milling, in a correctly adjusted curd-mill, results in improved texture of the cheese.

after manufacture show a tendency to be open in texture or lack smoothness it is probable that the curd would have benefited from longer holding at this stage. On the other hand, holding the curds for too long a time may result in them becoming greasy thus leading to defects in colour and texture. On the average, normal curds should develop the desired characteristics for salting in a period of about 35 minutes.

In warm weather it is sometimes necessary to cool the curd before salting. Curds that are salted and put to press at temperatures in excess of 89-90 deg. F are likely to suffer high fat losses in pressing. On the other hand the temperature of fall and winter curds should not fall below about 85 deg. F at this stage.

Care should be taken to avoid the sun shining directly on the milled curd as it is likely to injure the colour of the cheese.

Salting the Curd

The addition of salt serves not only as a preservative for the cheese but also seasons it and improves body and texture. The rate at which it is applied should be varied according to the fat content of the milk. The following is a good guide:

Fat Test of Milk %	*Rate of Salt* (lb. per 1000 lbs. milk)
Up to 3.1	2.0
3.2 - 3.6	2.25
Over 3.6	2.50

Occasionally it may be desirable to use a higher rate as for example in the case of curds containing excess moisture.

The following rules should be kept in mind.

1. Keep the salt supply clean and dry.
2. Weigh the correct amount of salt accurately.
3. Spread it evenly over all the curd adding it in two or more applications. Break up any lumps of salt or curd and stir thoroughly.
4. Do not begin hooping the curd until the salt has dissolved on the curd and the brine is draining freely. The longer the curd is stirred in the brine, the higher will be the salt content of the cheese.

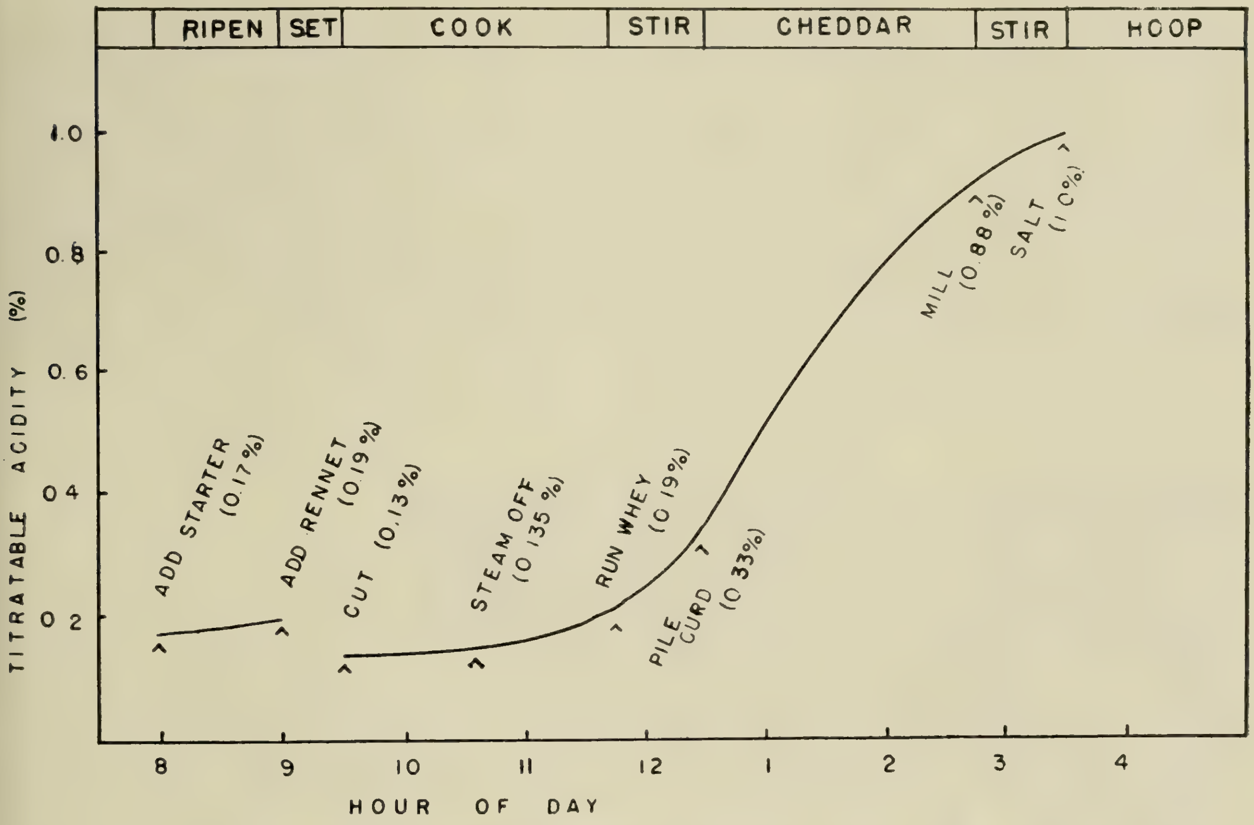

FIG. 13 Graph illustrating titratable acidity changes in the milk and whey during Cheddar cheesemaking. The acidities shown for the various steps in the process are average values which have been found to give satisfactory curds for milk testing 3.2 - 3.5% butterfat. It is not suggested this curve will apply to all conditions by any means. However, if the milk is of good initial quality, the rate at which the acidity changes take place should follow rather closely the rate depicted above.

Hooping

Enough hoops to take care of the day's curd should be prepared before the curds are salted. These should be clean, free from rust and "lime" and in good mechanical condition. The hoops are prepared for filling by placing a clean press cloth and starched circle in the bottom of the hoop after which the bandager, fitted with a properly cut bandage and skirt, is placed in the hoop. Curd is now pailed in, the bandager being raised while the curd is pounded into the hoop. Precautions should be taken to maintain the greatest possible uniformity in the size of the cheese. This can best be done by weighing the curd into the hoops. When filled, the curd is covered with another press cloth, a follower placed in position, then the hoops turned down and gradually increasing pressure applied for the next 40 minutes.

If the pressure during this period is increased gradually, brine will not be trapped in the cheese and thus cause openness. In addition, fat losses will be kept down and there will be less danger of trouble from greasy surfaces, cracked rinds and wavy colour.

DRESSING AND PRESSING THE CHEESE

After the cheese have been subject to this gradually increasing pressure for 40-45 minutes, they should be firm enough for dressing or bandaging. Either one of two methods may be followed in performing this operation. It can be done most rapidly and with least effort by allowing the cheese to remain in the hoops. If this is done however, some waste of bandage cotton is necessary, and more time is required to apply the skirt to the bandager when hooping the curd. Plenty of overlap should be allowed at the bottom of the hoop and the seam of the bandage should be straight. Press cloths should be clean and free from "lime." In performing the bandaging operation, the hoop is set upright in the press, the follower and upper press cloth removed, and the bandage then pulled up until snug and free from wrinkles. The waste bandage is then trimmed off, the lap turned in, and a starched circle placed in position. The upper press cloth is next soaked in water and then replaced on the upper surface of the cheese. The edge of the skirt is then turned in and the ring and follower replaced. Just before turning the hoop down in the press about two quarts of water should be poured onto the surface of the follower. During cool weather, rinding will also be aided if the outer surfaces of the hoops are washed with plenty of warm water. During cold weather, hot water should be used.

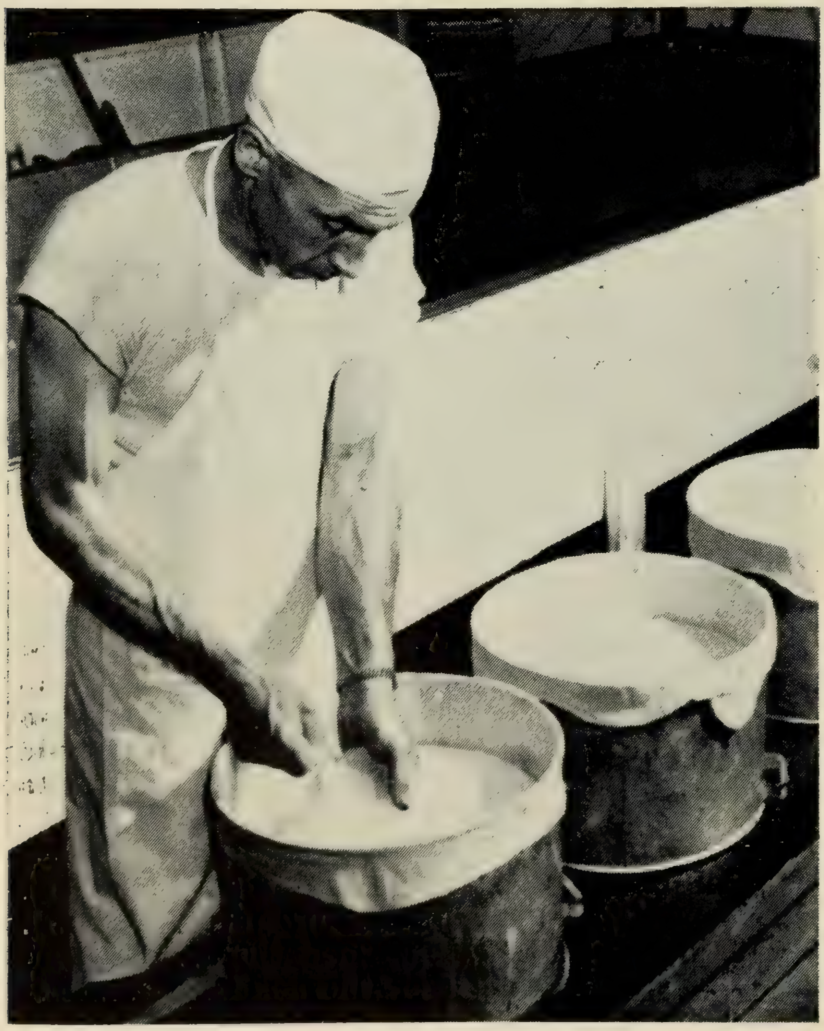

FIG. 14. Some of the details of bandaging cheese in the hoop are illustrated here. After the hoop-follower and the upper cap-cloth have been removed the skirt and bandage are each in turn pulled upward until the operator is sure that all wrinkles have been removed. The excess bandage cotton is then trimmed off and the end of the cheese finished by applying a starched circle and by turning in the skirt edge and replacing the cap-cloth and follower. The surface of the follower should then be flooded with clean water in order to aid in rinding the cheese.

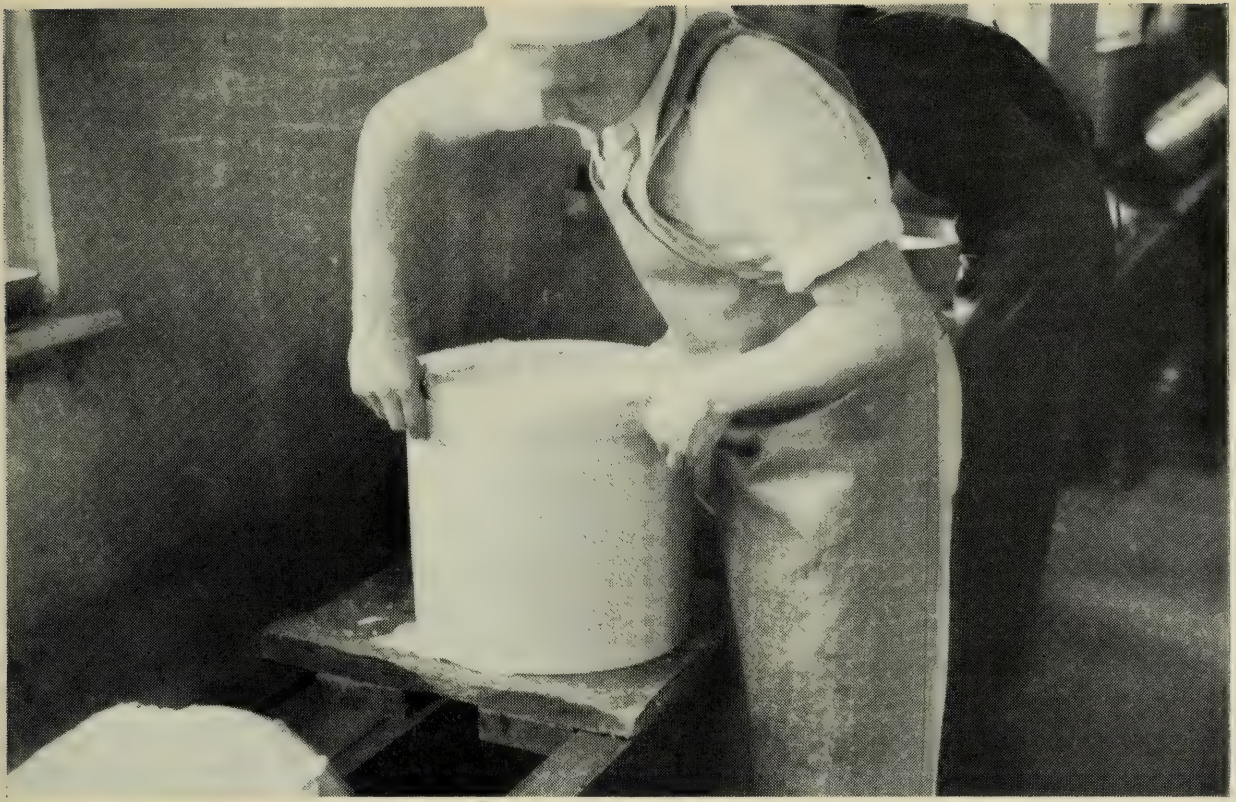

FIG. 15 If the practice of removing the cheese from the hoops for dressing is followed, the first operation consists of pulling up the bandage until perfectly snug. The seam of the bandage should be checked for straightness at this stage.

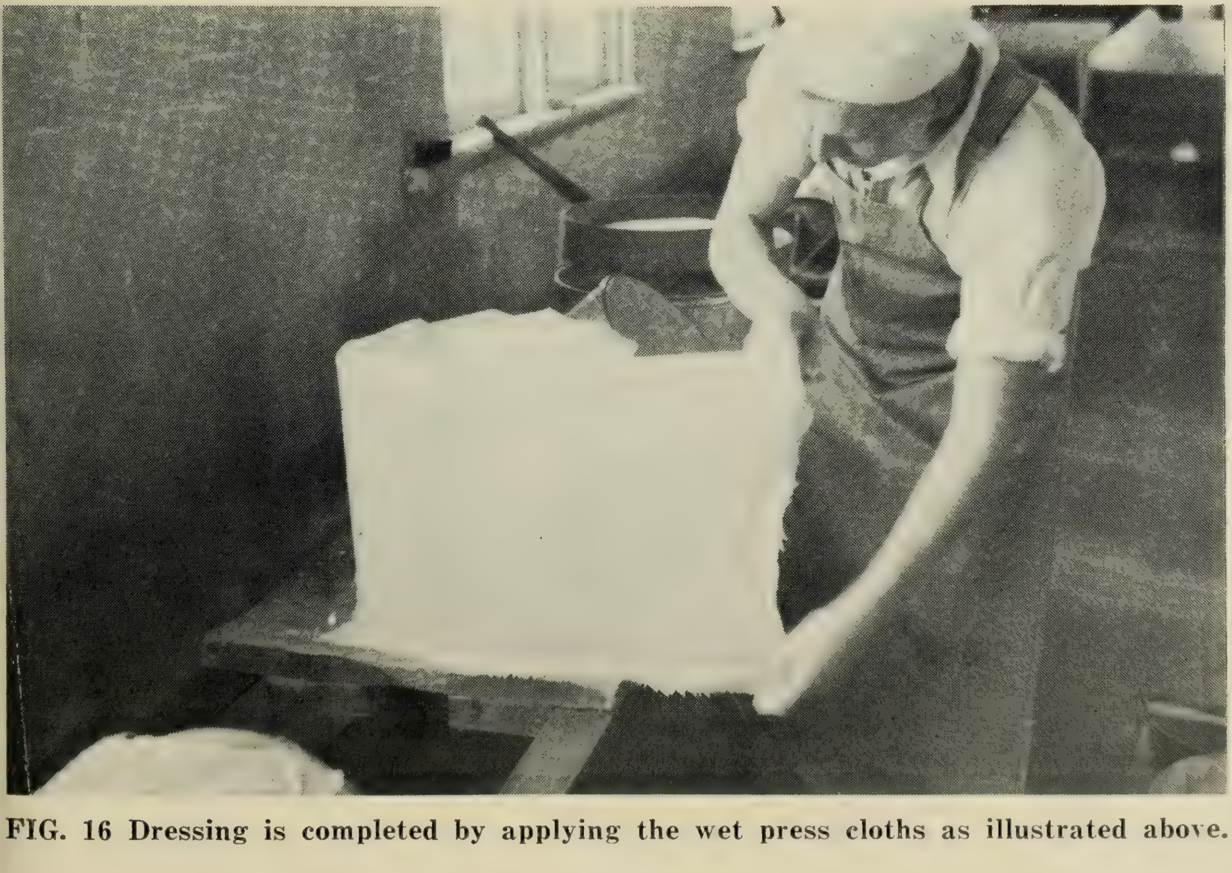

FIG. 16 Dressing is completed by applying the wet press cloths as illustrated above.

Removing cheese from the hoops for bandaging has the advantage that waste of bandage cotton is reduced, although this operation involves more work. As with the previous method, bandages must be pulled up until free from wrinkles and neatly lapped over the ends of the cheese. Starched circles and press cloths should then be placed on the ends of the cheese, following which the wet skirt should be applied as illustrated in Fig. 16. A third wet cap cloth is then placed on the upper end of the cheese after which the hoop is placed on the cheese. The hooped cheese is then returned to pressing position.

The temperature of the water used in these operations must be varied according to the season of the year and temperature conditions in the factory. During hot weather, cold or tepid water is most satisfactory while in fall and winter, hot water will be necessary to obtain a good rind, particularly if the air temperature in the make-room declines to any extent after putting the cheese to press.

The personal interest of the man doing the work largely determines the final finish and appearance of the cheese. Cheese which present a carelessly finished appearance quickly prejudice both the grader and buyer, suggesting to them that the whole make-up of the cheese has been lacking in care.

After being returned to the press, pressure should again be applied and after a few minutes can be brought up to the maximum. Where there are several cheese in the press it will be necessary to re-tighten the press once or twice before leaving the plant in order that the cheese are well pressed. Fourteen or sixteen hours pressing should be sufficient although cheese that are inclined to be open will benefit if held in the press an additional 24 hours.

If the cheese hoops are in good mechanical condition and are fitted with expanding rings under the followers, there should be no necessity for turning the cheese in the hoops the morning following. However, if inspection indicates that the cheese are not of good shape or finish, this condition should be corrected and the cheese returned to the press for further pressing.

A word of caution is probably in order regarding the methods used in handling small amounts of curd which are left over at the end of the day's operations. If this material does not receive proper care it may go sour or become discoloured and thus cause defects when added to the next day's curds. It is sometime convenient to press this curd into a flat or one or more Stiltons if suitable hoops are available. In case cheeses of these sizes are not easily sold however, the curd may be pressed in a hoop of standard diameter using a full length bandage. On the following day this cheese is filled out by adding to it the necessary amount of curd. In order to help knit the two portions together, however, the upper surface of the pressed cheese should be dug up with a cheese knife and flooded with about one-quarter pail of warm water before the fresh curd is added to it.

PREVENTING THE ENTRANCE OF EXTRANEOUS MATTER FROM FACTORY SOURCES

Assuming that the milk supplied to the factory is relatively free from sediment and that it has been carefully filtered or clarified upon receipt, the need is also apparent for keeping the curd free from extraneous matter of factory origin. Extensive surveys on this problem, conducted within recent years, indicate that the foreign matter entering the curd during the manufacturing stage consists chiefly of the following: coal dust and cinders, cloth fibres, metal, rubber belt fragments, rust and scale, hair and insect parts. Occasionally materials such as bristles, glass, grease and other contaminants are found. While the presence of some of the above substances is contrary to the Food and Drug Act, their entrance should also be rigidly prohibited on aesthetic grounds.

Good plant housekeeping is the answer to this problem in almost all cases. Coal dust and cinders must be prevented from entering the make room by the installation of dust tight, self-closing doors. If the boiler room opens directly into the factory, a connecting passage with doors at both ends should be installed. The handling of coal, the cleaning of grates and flues, etc., should be kept to a minimum during curd-making operations. Where the yard surrounding the plant is paved with cinders, a dust-layer such as oil or calcium chloride should be used to treat it. Rinsing out all vats before beginning the days operations should be an invariable rule. The entrance of other types of extraneous matter also should be just as rigidly excluded. Light colored, non-linting material should be employed for workers' clothes and caps of similar material should always be worn. Pockets above waist level are inadvisable in work garments for food plant employees.

The source of such materials as metal and belt fragments is usually due to improperly adjusted or designed agitators or agitator drives. Satisfactory belt guards and gear housings should enclose all drives likely to produce this type of contamination.

Rodent hairs and insect fragments are by far the most offensive type of foreign matter found in foods. A systematic control program for eliminating vermin and insects should be religiously carried out at all food producing plants.

Removing Cheese from the Press

Unless the hoops are dented or badly limed up it should be possible to remove the cheese without danger of damaging them. Some operators find it necessary to pound the hoop excessively to remove the cheese and this sometimes causes checks or slits in the cheese. The lime on the interior of hoops can be removed by allowing them to stand for a day or two in real sour whey, followed by a thorough scrubbing.

Every effort should be made to turn out a clean-surfaced cheese. If the hoops are rusty or greasy, or if press cloths are not clean, an unattractive cheese may be the result. Do not allow the cheese to come in contact with a dirty truck or rusty presses.

Branding

It is usually most convenient to carry out the branding or stamping of the cheese immediately after they are removed from the press and before they are placed on the curing room shelves. The branding must be neatly and legibly applied and should comprise the following information: day, month and year of manufacture, factory registration number and vat number. In the case of cheese of 60 pounds or over which

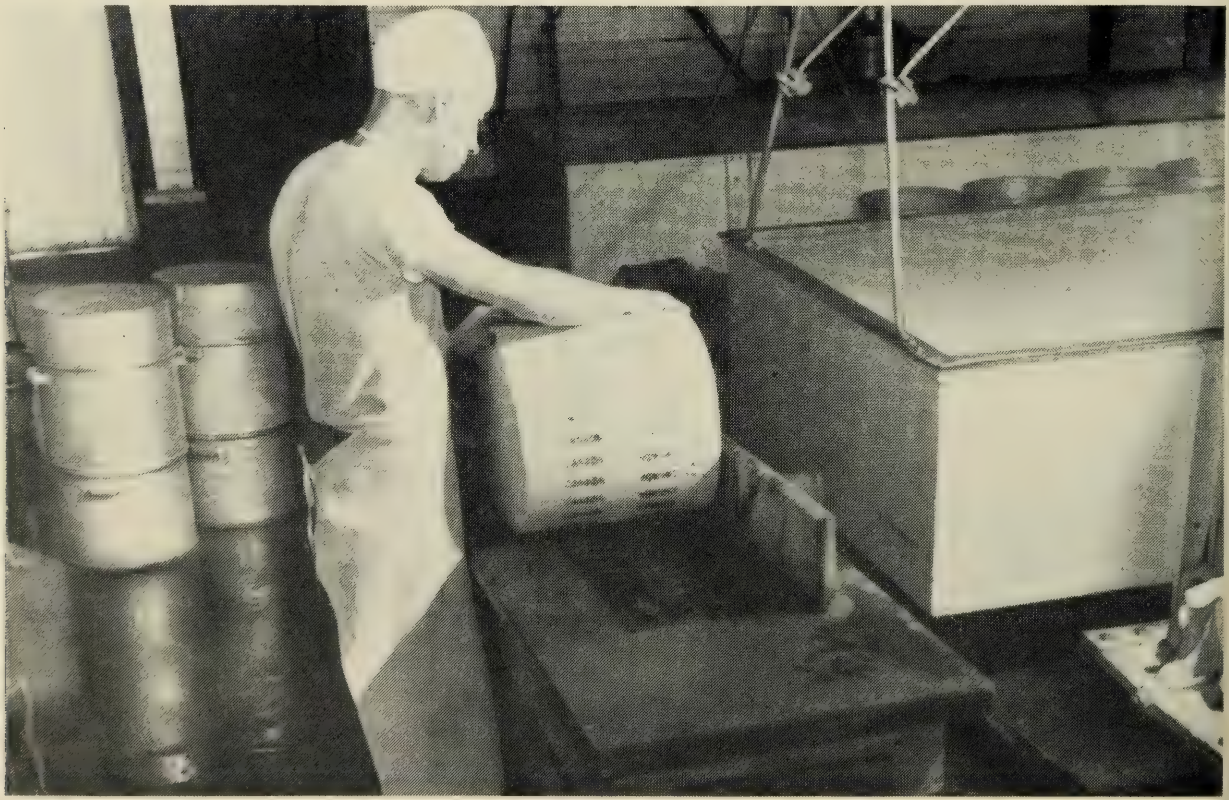

FIG. 17 Cheese intended for export must be branded in the above manner in order to ensure their identity as Canadian cheese in the export market. Clear, legible brands indicating the date of manufacture (day, month, and year), factory registered number and vat number are also required.

are intended for export, a special branding device is employed which, in addition to the above information, stamps the word "Canada" 58 times on the curved surface of the cheese. In order to comply with *The Dairy Industry Act,* all cheese must be branded within 24 hours after removal from the press. These regulations also prescribe the size and style of type which must be used. The manner in which export cheese are branded is illustrated in Fig. 17.

The cheesemaker's responsibility does not end once the product is placed in the curing room. The development of a sound, firm rind on the cheese must next be accomplished and this can only be done by drying the cheese slowly at a uniform temperature and under conditions of controlled humidity. To ensure proper rinding on the ends of the cheese, it is essential that turning of the cheese be done daily. Cheese intended for export must be held on the shelves for eight full days and be turned daily for this period. Some of the troubles encountered in caring for cheese during this period are dealt with below.

Mould

At certain seasons of the year a good deal of trouble is experienced with mould. No entirely satisfactory system of controlling this nuisance is known unless chemical mould inhibitors are employed. It can, however, be held in check where a combination of the following measures are followed.

1. Shelves must be kept clean and free from mould. This is not difficult if the shelves were properly finished before being put in service. Treatment of new shelves with shellac or a synthetic enamel will produce a surface which can be kept free from mould without a great deal of effort. As soon as the cheese are removed from any shelves, the surfaces should be wiped clean with warm water and a detergent, after which they should be wiped lightly with a cloth that has been dampened with a ten per cent solution of sodium propionate* or an appropriate strength solution of some other satisfactory mould inhibitor. Before cheese are again placed on them the shelves should be given an opportunity to dry thoroughly.

2. Air circulation should be provided. Mould growth is encouraged where the air in contact with a damp surface is not in motion since under these conditions the surface moisture will be high. However, with satisfactory air circulation, surface moisture will be taken up and mould growth checked even though the relative humidity is comparatively high.

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* This substance is sold under the trade name "Mycoban".

3. Some system of de-humidifying should be employed. In many recent installations, one or more fin-coil cooling units are located close to the ceiling and near one wall of the curing room. These coils are fitted with fans to circulate the air. If the equipment has been designed properly the flow of refrigerant to the coils will be intermittent. During the time the room is being cooled moisture will collect on the fin-coils as frost. As soon as the flow of refrigerant is shut off the frost on the coils melts to water which should be drained away. It should be remembered that every cheese of export size placed in the room is destined to lose one or more pounds of water during this drying period. If no facilities are provided for removing this moisture from the air there is certain to be much trouble with mould.

4. Temperature fluctuations should be kept at a minimum. Whenever the air in the curing room warms up rapidly, moisture from it will condense on the surfaces of the cool cheese. As was stated above, this surface moisture encourages mould growth.

If the cap cloths are left on the ends of the cheese until a day or two before boxing it generally results in cheese which arrive at the grading station in a cleaner and less moulded condition.

Cracked Rinds

Trouble of this character sometimes occurs in fall and winter cheese when good rind qualities are more difficult to produce. Plenty of hot water should be used in dressing the cheese and one should be sure that the cap cloths are free from grease and scale. Starched circles should be used on the ends of the cheese. Exposing the cheese to too rapid drying during the first day or two should also be avoided.

Paraffining

Most of the cheddar cheese sold to the domestic trade in Canada is paraffined shortly after manufacture. This

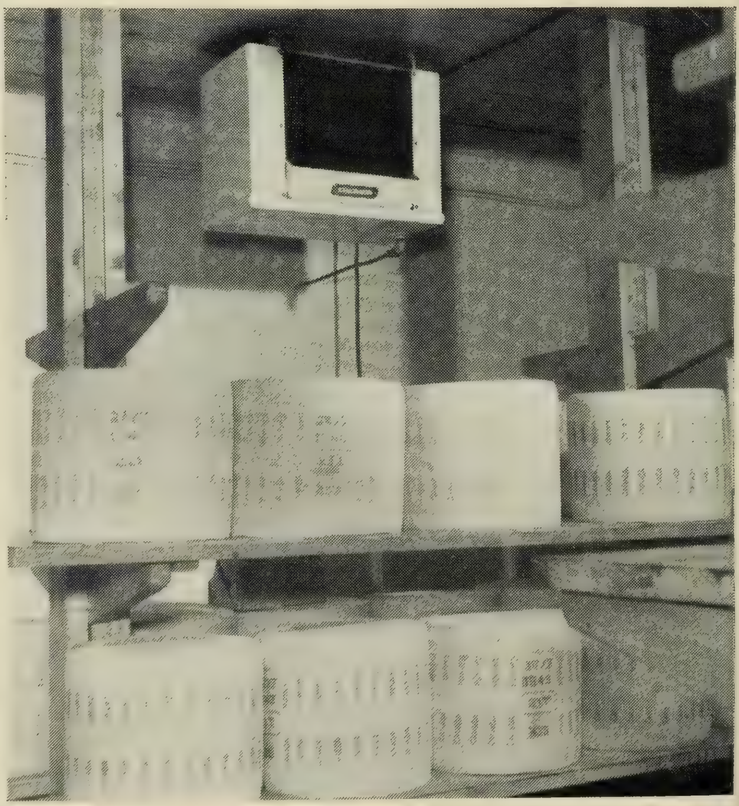

FIG. 18 It is highly important that the refrigerating unit and cooling coil be of sufficient capacity to maintain the desired temperature in the cooling room. In addition to cooling, however, this coil is the chief means of de-humidifying the room and the installation should be designed to do this efficiently.

may be done either at the factory where the cheese are made or at an assembling warehouse. It is really more convenient to paraffin the cheese before boxing at the factory and where this is done a price adjustment is always allowed.

Paraffining not only improves the appearance of cheese and prevents moulding but, what is more important, it reduces the rate of shrinkage. Losses from evaporation are about five times more rapid in unparaffined cheese.

Paraffin-wax with a melting point of 133-135 deg. F. is commonly used for this purpose although there are a number of special waxes on the market which are more shatter-resistant than the ordinary variety. Unless one of these is used the paraffin should be heated to about 220 deg. F and the cheese immersed for six seconds. Small sized cheese should be given a second dipping as an additional protection against shrinkage. This exposure kills many of the mould spores on the cheese surface and results in a tighter bond than when lower temperatures are used.

Paraffin adheres poorly to damp surfaces and because of this the cheese should be dry and well-rinded. Transferring cheese from a cold curing room to a warm, humid atmosphere will result in moisture condensing on them.

Weighing and Boxing

In weighing cheese, the weight branded on the box must be reduced sufficiently to allow for any shrinkage which takes place from the time of weighing until the shipment is checked at the assembler's warehouse. This "up-beam" weight may be as little as one-quarter pound in the case of well dried, paraffined cheese, to almost a full pound for unparaffined cheese that may be held several days before being graded. While this allowance is necessary it is no excuse for careless weighing or the use of inaccurate scales.

The weight of the cheese should be clearly stencilled on the box. To comply with *The Dairy Industry Act* the weight should be indicated in type at least one and one-half inches high and one-half inch wide followed by the abbreviation LBS in block letters one inch high.

Cheese are usually boxed immediately after being weighed. In addition to the weight, the box is stamped with the factory registered number, as well as with the vat number and date of manufacture of the cheese. Scale-boards should be provided for both the top and bottom of the box and the box trimmed, if necessary, to conform with the size of the cheese. Boxes that are too large for the cheese are soon broken and the cheese is likely to be damaged. On the other hand, boxes that are too small are even a more frequent cause of damage to the cheese. The smaller end of the cheese should go into the bottom of the box.

Temperatures to Maintain in the Factory Curing Room

The Dominion Department of National Health and Welfare has established regulations which require that during the first ten days of curing the temperature shall be maintained at not less than 58 deg. F. for Cheddar and similar varieties of cheese. Spring and summer cheese should not be exposed to temperatures much above this level. However, fall and winter cheese will usually grade higher if held at a slightly higher temperature, up to 65 deg. F. being advised. Temperatures in this range are only suitable for new cheese. As cheese become older they will require to be held at a lower temperature. (See section entitled Curing Cheddar Cheese, below.)

THE NECESSITY OF KEEPING LOSSES AT A MINIMUM

Efficient operation is fully as important in the management of a cheese factory as in any other manufacturing plant. Among the factors which influence factory efficiency, none is more important than the prevention of waste and loss. These may assume many forms and become so serious as to force the business into bankruptcy. Wastage of employee time, of steam and power, damage to factory equipment, spillage of milk and cream, etc., are all factors which must be reduced to a minimum if plant operating costs are not to be excessive.

Assuming that good management practices are observed in the above details of factory operation, it should also be borne in mind that the efficient cheesemaker constantly strives to obtain the highest possible yield of cheese without compromising quality. The cheese yielding capacity of a given milk supply is closely related to the composition of that milk and there is usually very little that the cheese factory operator can do to alter the composition of the milk received. Nevertheless, there are several factors which the cheesemaker has under his control which have an influence on yields and which the cheesemaker should supervise closely. These consist of:

1. The amount of water, salt and mineral matter retained in the cheese;

2. The losses of fat and casein in the whey;

3. The extent to which the cheese "shrink" before being marketed.

Retentions of salt and mineral matter cannot be varied greatly in the Cheddar process but it is possible to vary the moisture content within prescribed limits. Provided the milk supply is of high quality, it is good practice to take advantage of this fact and maintain moisture values at the highest level permissible with good grades. Milk supplies of poorer sanitary quality produce curds which must be cooked higher and stirred drier with the result that yields are reduced. Since there is no legislation governing moisture content in Canadian Cheddar cheese, the maker must be guided by his experience as to what constitutes the optimum mosture content consistent with the texture quality he desires. The use of moisture tests as an aid to greater uniformity and improved yields should be more widely adopted by Ontario cheesemakers.

Many factors have a bearing on the proportion of fat lost in the whey. Two of the chief causes of high loss are unsatisfactory coagulation and excessive agitation of the freshly cut curd. Losses are also increased in curds that are heated to excessively high temperatures or that have to be handled too quickly because of over-ripened milk. High losses of fat in the press whey should be guarded against by having the curd at the proper temperature for pressing and by avoiding the use of excessive pressure on the curds immediately after hooping. Butterfat tests on the whey in excess of 0.25 per cent indicate abnormal losses.

Losses of casein are seldom of great magnitude and when they occur are usually the result of carelessness. These can be maintained at a minimum by the use of good whey strainers and by avoiding the practice of stirring the curd while the whey is being run. In addition, casein losses are apt to be greater if the vat consists, to too great an extent, of fine particles of curd. These are sometimes produced if the curd is subjected to careless cutting or rough handling while soft. Every pound of casein lost seriously affects the yield since it carries with it approximately one pound of water.

Shrinkage prior to marketing is another factor which has a bearing upon yield. Moderate losses at this stage must be anticipated if the cheese are to dry properly and form sound rinds. On the other hand, however, excessive evaporation should be prevented. This can be accomplished by paraffining the cheese, (if for the home market,) when sufficiently dry, by careful regulation of curing room temperatures and humidities and by reducing the rate of air circulation to the minimum.

THE GRADING OF EXPORT CHEESE

The reputation for quality which Canadian cheese enjoys in export markets has been built up through the years by grading our product carefully and selling on the basis of these grades. This service is performed by officers of the Marketing Service of the Dominion Department of Agriculture and is generally done at the assemblers' warehouses. It is compulsory for cheese intended for export but since domestic wholesale trading is done largely on the basis of these grades, most of the cheese made in Canada are offered for grading.

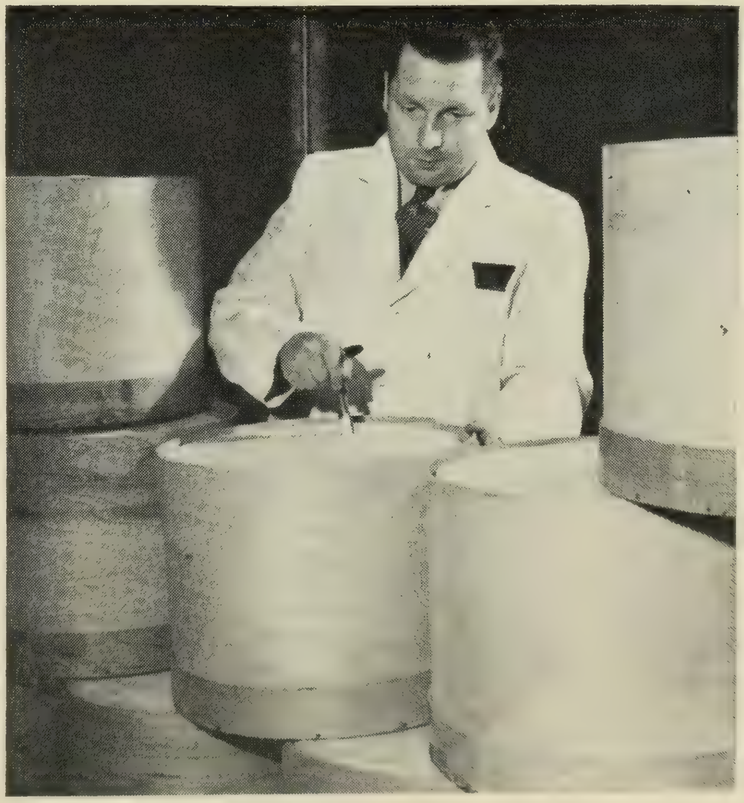

FIG. 19 The grade placed on a vat of cheese is an assessment of its quality based on flavour, body and texture, closeness, colour and finish.

The grader examines

one cheese out of each vat and decides on the grade by assessing a number of qualities. First grade cheese must be clean in flavour, while texture, closeness, colour, finish and boxing must be satisfactory. Flavour defects such as "slight rancid", "fruity" or "not clean" account for the majority of second grade cheese. The scores and definitions for grades comprise part of *The Dairy Industry Act.* First grade cheese must score at least 39 out of 45 points for flavour and at least 92 out of 100 points for total score. Flavour and total scores below 39 and 92 respectively, are applied to second and third grade cheese. Cheese below third grade are given no score.

The grade into which the cheese falls is stamped on the box. In addition, certificates are issued by the grader covering the shipment.

CURING CHEDDAR CHEESE

Before cheese is ready for consumption it must be aged or matured to develop flavour and mellowness. The time required may vary from a minimum of three months to up to two years or even longer. Generally speaking, cheese from three to six months old are described as "mild" or "medium" while cheese cured for nine months or longer are sold as "old" or "well-aged".

Some knowledge of the principles involved is necessary to an understanding of the process as it is a complicated one involving both bacteriological and chemical changes. Both the starter organisms and the rennet extract enzymes play a part in it.

The starter organisms (known to the bacteriologist as *Streptococcus cremoris*) continue to increase in number for a few days following manufacture. In doing so they complete the fermentation of any milk sugar which may be present in the cheese. They then begin to die off so that at the end of six months they can no longer be found in the cheese.

These organisms contribute to flavour to some extent. However, they also set up the acid condition in the cheese which is so necessary for good keeping quality.

In the later stages of ripening, organisms of the type known as *Lactobacillus casei* take the place of the streptococci. These organisms, and others associated with them, aid in flavour production.

The enzymes present in rennet extract play an important part in ripening by breaking down the casein of the curd. This action goes on throughout curing and is hastened by using high temperatures. As these reactions progress the cheese becomes more mellow and more easily digested.

The fat is also changed to some extent during ripening and it is now thought that certain by-products of this change contributes much to the flavour of old cheese.

The minimum temperatures for the first 90 days of curing are now specified by Dominion regulations. For the first ten days the temperature must be maintained at not less than 58 deg. F., while for the remainder of this period it must be not less than 45 deg. F. Temperatures much above these levels are seldom used since higher levels often result in the development of off-flavours.

During the curing period the cheese must be protected from damage by such things as undesirable moulds, mites*, vermin and excessive shrinkage. This is accomplished more readily if the cheese are shelf cured.

CALCULATING THE YIELD OF CHEESE

The cheese yielding capacity of milk is usually expressed in the following terms:

1. Yield in pounds of cheese per 100 pounds of milk;
2. Number of pounds of milk required to make one pound of cheese;
3. Yield of cheese per one pound of fat.

Either of the first two methods may be used in place of the other although the first is more common and probably preferable.

Monthly yields are of special interest, but it is sometimes desirable to know vat or daily yields as well. Examples are given of each type of calculation.

No. 1 Find the yield per 100 lb. of milk where 642,790 lb. milk yields 61,927 lb. cheese.

642,790 lb. milk yields 61,927 lb. cheese

$$1 \text{ lb. milk yields } \frac{61,927}{642,790} \text{lb. cheese}$$

$$100 \text{ lb. milk yields } \frac{61,927}{642,790} \times 100$$

$$= 9.634 \text{ lb. cheese per 100 lb. milk.}$$

No. 2 Find the number of lb. of milk required to make 1 lb. of cheese where 61,927 lb. of cheese was made from 642,790 lb. of milk.

61,927 lb. of cheese is made from 642,790 lb. of milk

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*Ontario Dept. of Agr. Bul. 385, 1937, gives a description of the cheese mite and methods for controlling it.

1 lb. of cheese is made from $\frac{642,790}{61,927}$ lb. of milk

= 10.379 lb. of milk required for 1 lb. of cheese.

No. 3 **Using the above weights of milk and cheese, find the yield of cheese per 1 lb. of fat if the average test for the period was 3.74%.**

We have already seen in example No. 1 that the yield per 100 lb. of milk was 9.634.

That is, 100 lb. of milk containing 3.74% fat yields 9.634 lb. of cheese or 3.74 lb. of fat yields 9.634 lb.

$\therefore$ 1 lb. of fat yields $\frac{9.634}{3.74}$

= 2.575 lb. of cheese per 1 lb. of fat.

MANUFACTURING REPORTS

Some record covering the more important variables during cheesemaking is a necessity if one desires to relate grading results to manufacturing methods or milk quality. There is no need to record every detail of the process however, since many of these vary only slightly or not at all. The illustrated form is an example of the minimum amount of the information which should be known.

A condensed report that is accurate is of much greater value than an extended one that is inaccurate. If information of a special type is thought to be important it should be included under remarks.

A novel method of keeping track of the disposition of each patron's milk among different vats may be of interest. This consists of recording the weights on the milk sheet with a different coloured pencil for each vat. Thus the weights of all milk going into the first vat might be marked in black, those comprising the second vat would be in red, and so on. In this way it is possible to have a permanent record of the source of the milk comprising every vat.

MANUFACTURING REPORT

Vat No.	Wt. of Milk	Per cent Starter	Set		Cook Temp.	Run		Salt		No. Cheese	Remarks
			Time	Acid		Time	Acid	Time	Rate		
15/8											
370	8150	0.8	8.09	0.19	102	10.50	.18	2.10		8	
371	7926	0.8	8.45	0.19	102	11.30	.18+	2.40	2¼	8	
372	6390	0.7	9.20	0.185	101.5	12.05	.18	3.10		6	

HANDLING WHEY

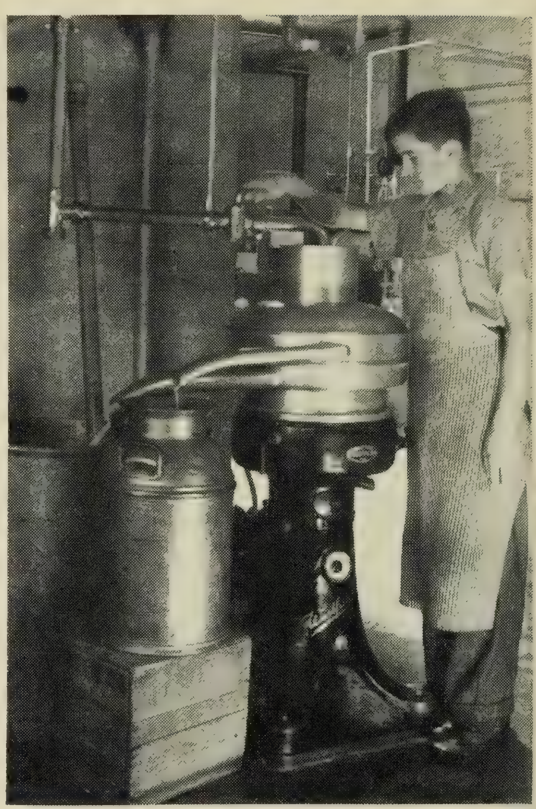

FIG. 20 A whey separator installed in a well-lighted, easily cleaned location.

The quality of cheese which a factory produces is often closely related to the degree of sanitation used in handling the whey. In plants where whey tanks, pumps and conductors are of improper constructions or are not maintained in a sanitary condition, difficulties with undergrade cheese are often a problem. This is particularly true at factories where the whey is returned to the farms in milk cans. In such cases the cans become contaminated from the whey and the organisms so introduced are carried over to the milk which is received at the factory on the following day. Yeasts and spore-forming bacteria are types which frequently become troublesome under these conditions and result in cheese with fruity or other defective flavours. For these reasons it is essential that the same rigid standards of sanitation should apply to whey handling equipment as to that used in handling milk. The regulations which require that tanks be cleaned daily and that the whey be properly pasteurized should be carefully complied with since only in this way are the above troubles avoided. *The Ontario Dairy Products Act* defines proper pasteurization for whey as heating to 155 deg. F. and holding for 30 minutes. Regulations under this Act also require the cheese factory patron to remove his share of whey from the factory each day or be liable for the expense of having it removed.

Whey cream is a valuable by-product of cheesemaking and separators for recovering this item are found in all factories. The great bulk of the whey removed at the running stage yields most of this cream. Many more factories however, should redesign their equipment to allow them to salvage the butterfat now lost in the press whey. The fat content of this material often runs as high as 5-7 per cent compared to an average of about 0.25 per cent in the whey at running.

Extra attention given in caring for the whey cream is well repaid in better quality whey butter. Good practice demands that a cream of average fat content be separated and that the cream be pasteurized and cooled immediately after separation. The flavour of the resulting butter will be improved by diluting the cream prior to churning with pasteurized skimmilk and by adding about ten per cent of good flavoured starter. Every effort should be made to produce as firm bodied a butter as possible. This can best be accomplished by churning at low temperatures, avoiding an over-loaded churn, and firming the butter granules well before working the butter.

FOOD VALUE OF CHEDDAR CHEESE

The important role which nutritious foods play in the building of a healthy nation is receiving more and more attention from health authorities. Of these foods, milk and its products have long been known to possess superior qualities in promoting health and growth. While a great deal of study has been given these properties and much has been written concerning them, the chief nutritive virtue possessed by dairy products can be described in a few words. Undoubtedly their greatest merit is their "protective" quality. Because modern diets are often deficient in protein, calicum and certain members of the vitamin B group, milk and its products are prescribed to forestall these deficiencies since they are rich in these nutrients. They plug the leaks which would otherwise result in lowered human efficiency.

When milk is converted into Cheddar cheese, most of the important nutrients are retained although certain unavoidable losses do take place in the whey. The latter consist chiefly of milk sugar and albumin. It is important to note that most of the fat and the casein, together with the larger part of the mineral matter remains in the cheese. Values indicative of the fate of milk constituents in cheesemaking are presented in Table 1, while in Table 2 is shown the extent to which an average serving of cheese contributes to the daily requirements for a man and a child with respect to five important nutrients.

TABLE 1

Retentions and losses of milk constituents in Cheddar cheesemaking.

Approximate values based on 1000 lbs. of 3.8 per cent milk.

	Milk	*Cheese*	*Whey*
Total Weight	1000 lbs.	100.0 lbs.	900.0 lbs.
Water	870	35.0	835.0
Butterfat	38	34.7	3.3
Casein	26	24.6	1.4
Albumin	10	0.5	9.5
Lactose	49	1.0	48.0
Mineral	7	2.5	4.5
Common Salt		1.7	

TABLE 2

Approximate contribution of a serving of cheese to the daily food needs*

Nutrient	*Cheddar Cheese 42.5 g. (1½ oz.)*	
	70-Kg. Man %	*19-Kg. Child Age 4-6* %
Protein	14	20
Calcium	46	37
Phosphorus	20	20
Vitamin A	15	30
Riboflavin	10	18

*Values taken from Newer Knowledge of Cheese, National Dairy Council, Chicago (1947)

Examination of the above tables indicates that cheese possesses many of the same constituents as does milk and that these nutrients are present in cheese in a more highly concentrated state. Roughly speaking, cheese may be considered as being one-third water, one-third butterfat and one-third milk-solids-not-fat, the latter fraction consisting largely of protein. The low moisture content of Cheddar cheese is illustrative of the superior economy of this food especially when compared to many other higher priced foods which often contain much larger amounts of water.

In several other respects however, Cheddar cheese is an outstanding value as a food. Its high content of excellent quality protein should be especially borne in mind. Cheese is also highly rated by dietitians as a good source of calcium and riboflavin, two nutrients which are frequently deficient in modern diets. It should also be noted that the butterfat fraction carries with it the vitamin A activity for which milk and butter are so highly regarded. Since a large part of our cheese is produced from summer milk, its value as a source of this vitamin is further enhanced. A vitamin A content of 7920 International Units per pound was the average value obtained in a recent study.

The alleged indigestibility of cheese is a false impression which is widespread and which should be refuted. This appears to be a superstition peculiar to North America where the custom of eating cheese as the last course of the meal probably lends some credence to the idea. On the contrary, experimental studies show conclusively that cheese is from 90 to 99 per cent digestible—a range which compares favourably with that found for other foods normally used in a mixed diet. In the cheese-eating countries of Europe where the average consumption is much higher than in Canada, this complaint is rarely heard, probably because it is more customary to use cheese in the meal as a replacement for meat.

ACKNOWLEDGMENTS

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THE HISTORY OF ORCHARD SPRAYING IN ONTARIO

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THE HISTORY OF ORCHARD SPRAYING IN ONTARIO

By Lawson Caesar

CONDITIONS WHICH LED TO SPRAYING

Although most of the insects and diseases found in our orchards today were here long before spraying began, yet according to the statements of observant and reliable men, among them Dr. William Saunders, Director of Dominion Experimental Farms, and Prof. John Craig, Dominion Horticulturist, crops of apples 60% to 75% free from insect and disease injuries were not uncommon in Ontario up to 1875 or even to 1880. Hence, previous to about 1880, there had been no urgent need for spraying as fruit growing was fairly profitable without it. From about that time, however, insect and disease injury increased so rapidly that by 1885, instead of many orchards having normally 60% to 75% of clean fruit, the great majority had only about 25%, and in some years even less. This high percentage of injury not only was making the export of apples to the British Isles and other countries unprofitable but also was ruining the home market. Such, then, were the conditions in Ontario that led thoughtful growers to see that if their industry were to continue profitable they must find some means of protecting the fruit from insects and diseases, and the only promising means seemed to be by spraying the trees with an insecticide and a fungicide.

It is interesting and important to know that Ontario was not the only province or state in which these conditions prevailed, for Quebec, Nova Scotia and much of the United States were facing the same problem at the same time and had come to similar conclusions.

In case anyone thinks that fruit growing must have been a small industry in those days, it will be interesting to know that the Dominion Census of 1871 shows that the total yield of apples in this province in that year was 5,486,504 bushels. This, of course, includes the apples from all orchards whether commercial or not. There were also many pears, plums, cherries and peaches. Perhaps this is not surprising because there were orchards in Ontario as early as the year 1800.

HELPFUL FACTORS

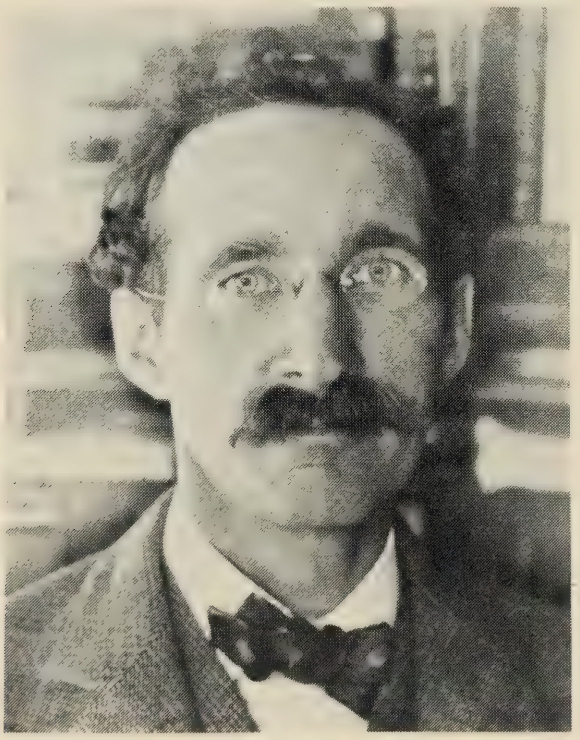
There were several factors which helped greatly in facilitating progress in spraying in its earliest stages. One was the discovery about 1868 of Paris green as an insecticide for the Colorado potato beetle. This gave such good results that by 1880 it was used extensively all over the province, not only against the potato beetle but also against several other biting insects. Hence fruit growers were of the opinion that here was the poison they needed for their orchards. London purple and arsenite of lime were also available but, though used by some for a time, they never became popular in Ontario.

A second great help was that Bordeaux mixture had been found, in 1882 in France, to be a good fungicide and had been tested to some extent by Washington experimenters a short time before the need for it was felt in

Dr. William Saunders, Director of Experimental Farms, Ottawa.

Ontario. In addition to Bordeaux mixture, it was known that ammoniacal copper carbonate and Burgundy mixture were also fungicides. So there were both insecticides and fungicides from which to choose.

Another helpful factor, not only at that time but even up to the present, was that the United States was battling with this same great orchard prob-



John Craig, Horticulturist, Central Experimental Farm, Ottawa; later Professor of Horticulture, Cornell University, Ithaca, N. Y.

lem, and that Ontario was welcome to take advantage of any discoveries made there just as they were welcome to share in any discoveries that might be made here.

Then last, but not least, there were three well-trained, able and enthusiastic men to lead and guide the new movement; namely, Dr. William Saunders, Prof. John Craig, both of them mentioned above, and Dr. James Fletcher, Dominion Botanist and Entomologist.

Dr. James Fletcher, Botanist and Entomologist, Central Experimental Farm, Ottawa.

Spraying is a very complicated matter. It involves a knowledge of entomology, plant pathology and chemistry. Fruit growers are too busy to devote much study to these subjects. Hence all through the history of spraying the leadership and help of men from the experimental stations and agricultural colleges and universities have been essential. This does not mean that the fruit grower has not helped. His experience and observations have been of very great assistance in many ways.

Having these helpful factors, the next step was to draw up a spray calendar showing when each application should be made and what materials should be used. This involved a knowledge of the life histories of the more important insects, especially the codling moth and plum curculio, and also of apple scab and other important diseases. Fortunately, Dr. Fletcher, Dr. Saunders, The Rev. Dr. C. J. S. Bethune and Mr. Baynes Reed had all been studying orchard insects for several years and had published the results of their studies in the Annual Reports of the Entomological Society of Ontario, and other publications. Dr. Saunders, moreover, had published an excellent book as early as 1883 on "Insects Injurious to Fruits". From these writings and from American publications, Fletcher and Saunders were able to determine fairly accurately the number of sprays required for control of insect pests and when each should be applied. It was more difficult to determine the times to spray for plant diseases. However, Craig, helped by information from the United States, managed to work this out fairly well.

THE PIONEER STAGE

The earliest orchard spraying experiments began about 1878. These were made by a few men here and there, men who, influenced by their success with Paris green against the potato beetle, decided to test this poison against the codling moth and other common orchard insects. Whenever Dr. Fletcher or Dr. Saunders heard of these efforts they gave the growers encouragement and the necessary information for success. As many of the experiments gave good results, the number of experimenters gradually increased. It must be remembered, however, that the spray was applied by hand machines of small capacity which could cover only a few trees a day, hence spraying of large orchards or large trees with these machines was not practical. Between 1885 and 1890 barrel sprayers, very similar to those still used today by many persons against vegetable and garden pests, began to come on the market. These were equipped with agitators, hose, bamboo rods, and fairly good nozzles. With such an outfit two men could spray in a day, about 100 trees of good size, hence their introduction made orchard spraying practicable though still slow and laborious. These outfits were greatly prized by progressive growers, who were as proud of them as the growers today are of their high-power sprayers.

Dr. Fletcher kept in touch with the work that was being done and guided it as well as time permitted. In 1885 he announced publicly that it had been proven abundantly that spraying to control insects was feasible and would increase greatly the percentage of clean fruit, thereby making fruit growing much more profitable. He therefore urged growers not to wait any longer but to adopt spraying at once as an orchard practice. Hence it may be said that spraying for the control of orchard insects was put on a firm basis as a very important and practical aid to fruit growing about the year 1885.

Up to the year 1890 there had been practically no spraying to control apple scab or other fruit diseases. However, in this year, Dr. Saunders, seeing the great damage being done in many orchards by apple scab, authorized Craig to begin this work. Accordingly in 1890 a fourteen year old Fameuse (Snow) orchard was selected by Craig and sprayed with ammoniacal copper carbonate. This was the beginning of commercial spraying for fungus diseases. The results were encouraging but not strikingly so. However, they showed Craig that much more work must be done before he could speak with confidence on disease control. Accordingly, with the assistance of Fletcher and the hearty co-operation of leading members of the Fruit Growers' Association of Ontario, he undertook a series of carefully planned experiments extending over a period of five years. These tests were not to be limited to apples alone but were also to include pears, plums, cherries and peaches. They were aimed at the control of both insects and diseases. In them, all the most promising insecticides and fungicides were to be tested and observations made to determine the best times to spray, the number of applications required, and the proper strength of the various mixtures used.

RESULTS OF THE EXPERIMENTS

The following were the results:

1. Paris green was seen to be the best insecticide.
2. Bordeaux mixture, 4-4-40 formula, was found to be the best fungicide.
3. Paris green and Bordeaux mixture were proven to be compatible with each other. Moreover the addition of Bordeaux to the Paris green was seen to make the latter safer on the foliage and to increase its adhesiveness.
4. Paris green gave satisfactory control of the codling moth and most of the other biting insects, except that there was still considerable damage from the codling moth in the areas where two broods existed. There was also some doubt as to the effectiveness of Paris green against the plum curculio.
5. Bordeaux mixture gave good control of apple scab, brown rot, and cherry leaf spot, and seemed to help control black knot.
6. Bordeaux mixture in some instances did not control peach leaf curl. The reason, as discovered in 1897, proved to be that the spraying was done too late in the spring owing to a wrong theory of how the disease wintered over. When the spray was applied early—before the buds began to swell—the Bordeaux mixture gave excellent control.

Many will be interested to see the 1895 spray calendar prepared by Craig assisted by Fletcher. This calendar seems to have been little altered until about 1910 except that, after the discovery of lime-sulphur, a dormant spray, with this new mixture was applied in orchards infested by San Jose scale, oyster shell scale, or blister mite. In such orchards this spray was substituted for Craig's first application.

CRAIG'S SPRAY CALENDAR FOR APPLES (1895)

No. of Application	*Time*	*Mixture*
First	Before the buds start.	1 lb. bluestone in 25 gals. water.
Second	Just before blossoms open.	Bordeaux.
Third	Soon after blossoms fall.	Bordeaux and Paris green.
Fourth	10 to 15 days later.	Bordeaux and Paris green.
Fifth	10 to 15 days later, if scab severe.	Bordeaux.

Note 1. It is probable many growers added Paris green in the second application to control early feeding caterpillars such as tent-caterpillars and cankerworms when these were known to be present.

2. Craig said the bluestone alone in the First Spray was to kill spores on the bark.

3. Many growers for years used only the Second, Third and Fourth Sprays and usually got good results. In wet years, however, it was common to give an extra application.

CRAIG'S SPRAY CALENDAR FOR CHERRIES (1895)

No. of Application	*Time*	*Mixture*
First	Before the flower buds open.	Bordeaux (kerosene emulsion for aphids, if threatening)
Second	When fruit has set.	Bordeaux and Paris green.
Third	10 to 15 days later.	Bordeaux and Paris green.
Fourth	10 to 15 days later or a few days before picking.	Ammoniacal copper carbonate.

Note: The ammoniacal copper carbonate, Craig said, was much better for this last application than Bordeaux as it left less stain on the fruit.

PROGRESS FROM 1895 TO THE SAN JOSE SCALE CRISIS

During this period of approximately ten years, Paris green and Bordeaux continued to be the standard spray mixtures. Kerosene emulsion was recommended against aphids but very few growers used it, apparently because they felt the need was not sufficiently great to justify the trouble and expense. Fletcher said it was rarely that aphids were abundant enough to justify spraying.

Barrel spray outfits continued to be used by the great majority of growers, but in the larger orchards were gradually being displaced by double-action pumps installed on tanks of 120 to 200 gals. capacity. These made it possible to cover twice as many trees a day as with the barrel outfits. Two lines of hose were used with them and the pressure was about 150 lbs. In 1903 the great need of more powerful spray machines to fight the San Jose scale led to the introduction of gasoline outfits. These will be discussed later. Several other types of sprayers were also tested from time to time but none of them ever became popular.

EFFORTS TO POPULARIZE SPRAYING

Much could be written on the methods taken to encourage growers to adopt spraying but as most readers will have a fair knowledge of these methods, only the most important will be mentioned:

1. At the annual meetings of the Fruit Growers' Association of Ontario and also at local meetings of growers in each fruit district, spraying was

given a prominent place on the programme. Usually an outstanding leader, such as Dr. Saunders, Dr. Fletcher, Prof. Craig, or a little later, Prof. Lochhead of the Ontario Agricultural College, gave the main address and took part in the discussion which followed. However at the various local meetings men who were harvesting clean fruit told of their success and encouraged others to spray.

It is well to mention here that in 1897 Craig resigned from his position as Horticulturist at the Central Experimental Farm at Ottawa and went to Cornell University as Professor of Horticulture. His departure was a great loss because from 1891 he was the greatest driving spirit in the spray movement and had done a great deal to make it a success. He was succeeded by W. T. Macoun, who also helped in the work as far as his other duties permitted.

W. M. Orr, Supervisor, Spray Demonstration Orchards throughout Ontario.

2. In 1895 the Honourable John Dryden, Ontario Minister of Agriculture, feeling that not enough was being done to demonstrate the value of spraying, instituted a system of experimental orchards from Sarnia in the west to Cornwall in the east. Usually thirty orchards were selected for this purpose each year and in each a block of trees was to be sprayed and the rest of the orchard left unsprayed to furnish a check. The work was under a superintendent who was given three well-trained assistants. The first year A. H. Pettit of Grimsby was superintendent and the rest of the time W. M. Orr of Fruitland was in charge. The experiments were continued for at least five years and apparently longer. At each centre the growers were notified when the demonstration would take place and were invited to be present and ask questions. Many did so, for there are records of more than 100 being

present in several instances. In this work Pettit and also Orr followed pretty closely the spray calendar prepared by Prof. Craig.

After picking was completed the owner of each orchard was asked by the Department of Agriculture to report on the results of the spray tests and to state his opinion of the value of spraying. In these reports, it is interesting to find that almost without exception they stated that they were convinced that it would pay well to spray. There seems no doubt, as Mr. Orr said, that large numbers of men began spraying as a result of what they saw.

3. In addition to the above measures there was also the influence, in almost every district, of individual growers who were already spraying and securing much cleaner crops as a result.

4. The agricultural press and the Canadian Horticulturist from time to time published articles on spraying which helped. Moreover, Dr. Fletcher, Prof. Craig, Prof. Panton of the Agricultural College and Prof. Lochhead wrote circulars or bulletins on the subject. These were published and distributed by the Departments of Agriculture at Ottawa and Toronto.

In spite of these and other methods, progress in spraying was slow and it is doubtful whether up to 1904, more than 25% of the growers had spray machines and were using them. This was not to be wondered at since in those days the average farmer was suspicious of new ideas and methods and fell into line very slowly. It must also be kept in mind that spraying requires a great deal of thought, foresight, promptness, patience and thoroughness to make it successful. The spray outfits also were much inferior to those of today, consequently nearly half of those who tried spraying failed. This was true also in New York State. Others, seeing these failures, naturally hung back. Nevertheless nearly all progressive growers were spraying by 1904 or a little later.

THE SAN JOSE SCALE

This scale was first found in Ontario in 1897 but had evidently been here several years earlier. It is a very tiny, circular, brownish, sucking insect no larger than the head of an ordinary pin, yet capable of multiplying a millionfold in a single season and killing in three to six years all the apple, pear, plum and peach trees in an orchard. It spread very rapidly and by 1902 was distributed widely throughout the Niagara district and most of the counties bordering on Lake Erie. By 1904 it had destroyed hundreds of thousands of apple, pear, plum and peach trees and threatened ultimately to wipe out almost every fruit tree, at least in the warmer districts. Many growers, seeing the destruction and learning also of the losses in the United States, became almost panic-stricken with fear for their orchards.

The Ontario Department of Agriculture was likewise greatly worried and gladly responded to appeals for help by furnishing men and whatever funds were required in the search for a remedy. Dr. Fletcher and Prof. Lochhead, as entomologists, took an active part in all the investigations and helped greatly by their advice. George Fisher, a very able fruit grower of the Burlington district, was appointed Provincial Scale Inspector and put in charge of all inspection work. In addition he carried out most of the spray tests.

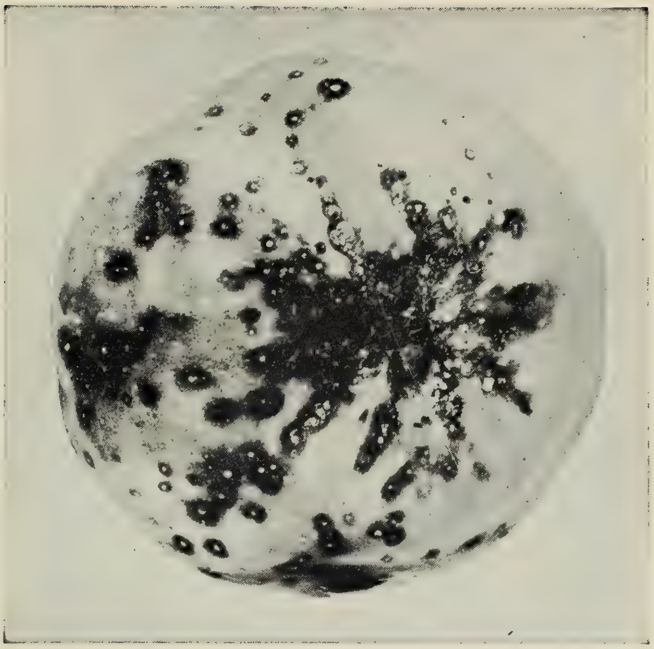
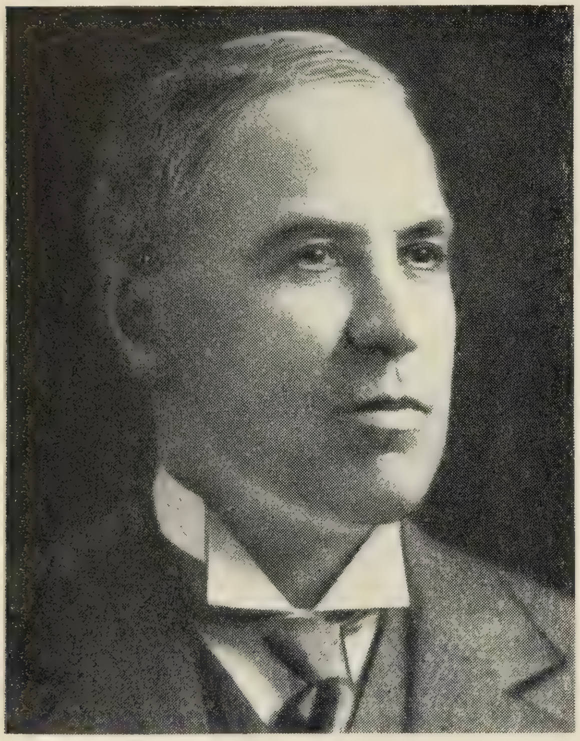


Fig. 7
Apple Infested with San Jose Scale.

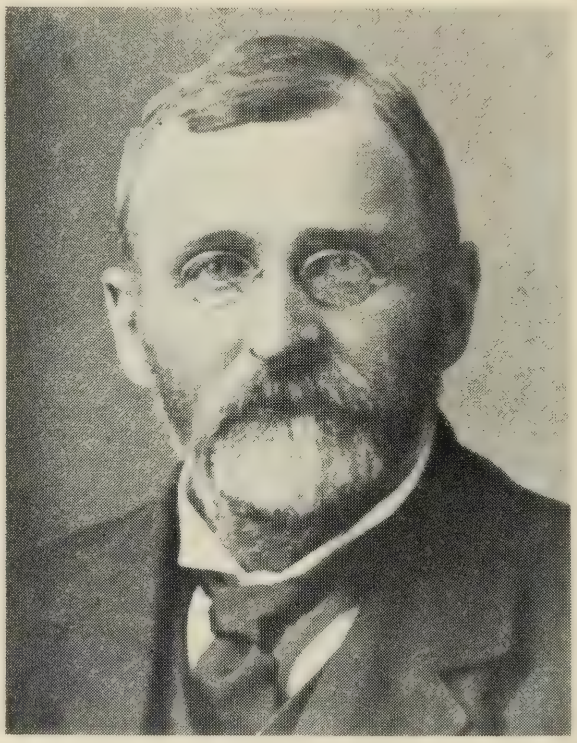
At first Fletcher and the other leaders thought that the scale could be exterminated by destroying every tree with scale on it in the infested areas. Authority was given by an Act of the Legislature to do this, but great opposition was aroused and many able men were convinced that extermination was not practical; so this method was soon abandoned. Meantime the search for an effective spray remedy was vigorously continued. During the first three years several mixtures were found which would kill the scale but none proved really satisfactory. Finally in 1901 a lime-sulphur-salt mixture, which was giving good results in California, was tested. In 1902 further tests showed that it was an excellent remedy and also that the salt could be omitted without any loss of efficiency. Fisher, who had conducted all the tests, now announced that at last a remedy had been found that was comparatively easy to make, cheap, safe and very effective. This discovery brought great relief and encouragement to fruit growers all through the infested areas and led all who valued their orchards to begin spraying. Even in the areas which were free from the scale many growers began to spray because of the fear that the insect might soon spread farther and ruin their orchards.

At this point it is of interest to note that experience has shown that in Ontario the San Jose scale is limited to the area south of a line from Sarnia to Toronto. It has been found also in orchards in other areas but has always died out before causing appreciable damage. It is also of interest to note that for about the last twenty years this scale even in unsprayed orchards, has not been nearly so destructive as formerly. This is largely because it has become more and more heavily parasitized. When it came here first it was nearly free from parasites and was able to multiply at an amazing rate. Occasionally, however, even now it becomes troublesome for a year or two and then subsides again.

From what has been said above it is evident that the San Jose scale was a very important factor in the progress of spraying: First, it showed that the grower, if located in a warmer district, either had to spray or lose his orchard. Second, it led to the discovery of a new and very valuable spray mixture, namely, lime-sulphur. Third, it showed the necessity for thoroughness of application, for, unless every part of the tree was wet with the spray, some of the scales would not be killed and would reinfest the trees later. Fourth, it led to the manufacture of much better spray outfits because it was seen to be very difficult to control the scale on large trees without a powerful spray machine. These four things led to more healthy trees, cleaner fruit, larger yields and higher prices. Also as a natural consequence they led men to take a greater interest and pride in fruit-growing.



William Lochhead, Professor of Biology, Ontario Agricultural College, Guelph.



George Fisher, Chief Inspector for San Jose Scale.

LIME SULPHUR

For several years this new spray mixture was made by the growers themselves. It was prepared by boiling sulphur and quicklime together in about 20 gals. of water for one hour and then diluting to 40 gals. The proportions of sulphur and lime varied but the most common formula was 15 lbs. sulphur and 20 lbs. quicklime. The boiling was done either by direct heat in large iron kettles or in vats with wooden sides and ends and a galvanized iron bottom, or sometimes in barrels or vats by steam supplied by a threshing machine engine or by a boiler.

It was very interesting in those days to drive through the Niagara district and see the growers, busy as bees, boiling the lime sulphur, then straining it into the spray tanks and hurrying to get it applied to the trees before it cooled. In a day or two after the spray was applied the orchards were all white and attracted the attention of everyone passing by.

A big drawback to this early form of lime sulphur was that it could not be made before spraying began and stored until needed but had to be applied while still warm and without any further dilution.

In about five years a method was discovered in the United States of making a concentrated lime sulphur which could be made at any time and stored until needed. This could easily be tested for strength by an hydrometer and diluted to the proper strength for the dormant and later sprays respectively. This was a great convenience.

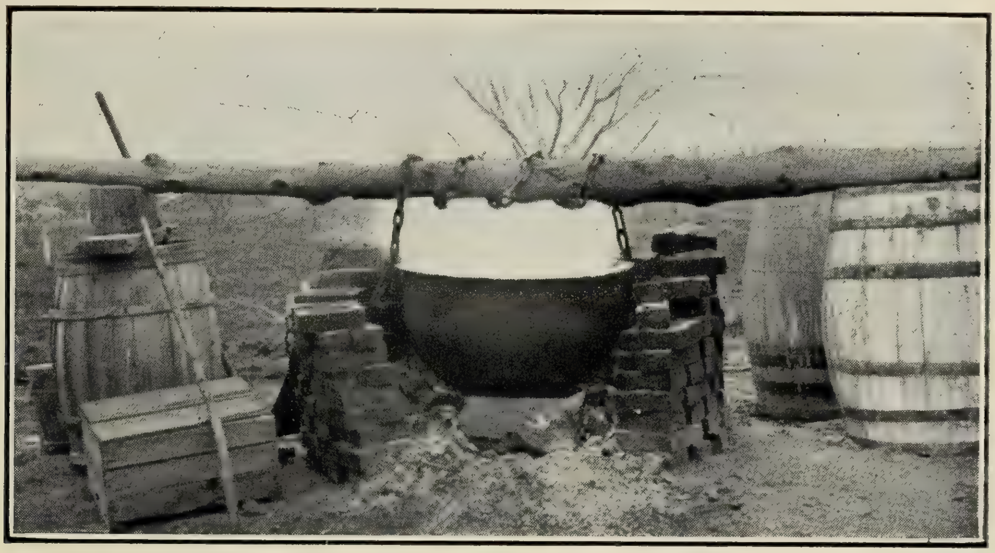


Fig. 8

Wooden vat with sheet-iron bottom much used for boiling lime-sulphur mixture by direct heat.

To guide them in making, testing and diluting of this concentrated spray, the writer in 1909 published a bulletin entitled "The Lime Sulphur Wash". This was revised in 1912 and was used for many years by growers. Gradually, however, the majority found it more convenient to buy the lime sulphur ready-made from the spray manufacturing companies.

The discovery of lime sulphur marks an important step in the advance of spraying. At first this new mixture was used solely to control the San Jose scale but soon was found effective in controlling two other pests which by this date had become very numerous and were causing serious injury to the health of orchards, especially in eastern and central Ontario. These were the oyster-shell scale and the blister mite. A single, thorough application of lime sulphur, as a dormant or semi-dormant spray, practically annihilated the blister mite on both apples and pears and reduced greatly the oyster-shell scale. Further, it was soon observed that when lime sulphur was sprayed on peach trees to control San Jose scale it also controlled the peach leaf-curl. This, therefore, made spraying peach trees with Bordeaux mixture no longer necessary.

A little later the discovery that lime-sulphur was a fungicide led to its being tested at a weaker strength to control apple scab, brown rot and other fungus diseases. The results were so satisfactory that it was placed on a par with Bordeaux mixture about 1910.

For several years previous to 1910 many growers had realized the need of a substitute for Bordeaux mixture, not because of any lack of fungicidal effectiveness, but because it was causing too much russeting of apples, especially Baldwins, Ben Davis, Jonathan and R. I. Greening. The russeting required that the apples be put in a lower grade when packing. It also was seen that in some seasons several successive, heavy applications of Bordeaux caused much of the foliage on apple trees to turn yellow and drop, thus weakening the trees. These two defects were aggravated by the greater amount of spray applied per tree following the introduction of high-power machines. It was therefore natural that growers should turn to lime sulphur as a substitute for Bordeaux. However, lime sulphur if combined with Paris green is injurious to the foliage. Hence a new insecticide was needed. Fortunately just at this time in the United States arsenate of lead was coming into use as a substitute for Paris green. It was first tested in Ontario about 1908 and found to be not only a good insecticide but also compatible with lime sulphur. The growers then soon began to use lime sulphur and arsenate of lead in place of Bordeaux and Paris green. The change-over of course was gradual, many for a time still clinging to the Bordeaux and Paris green.

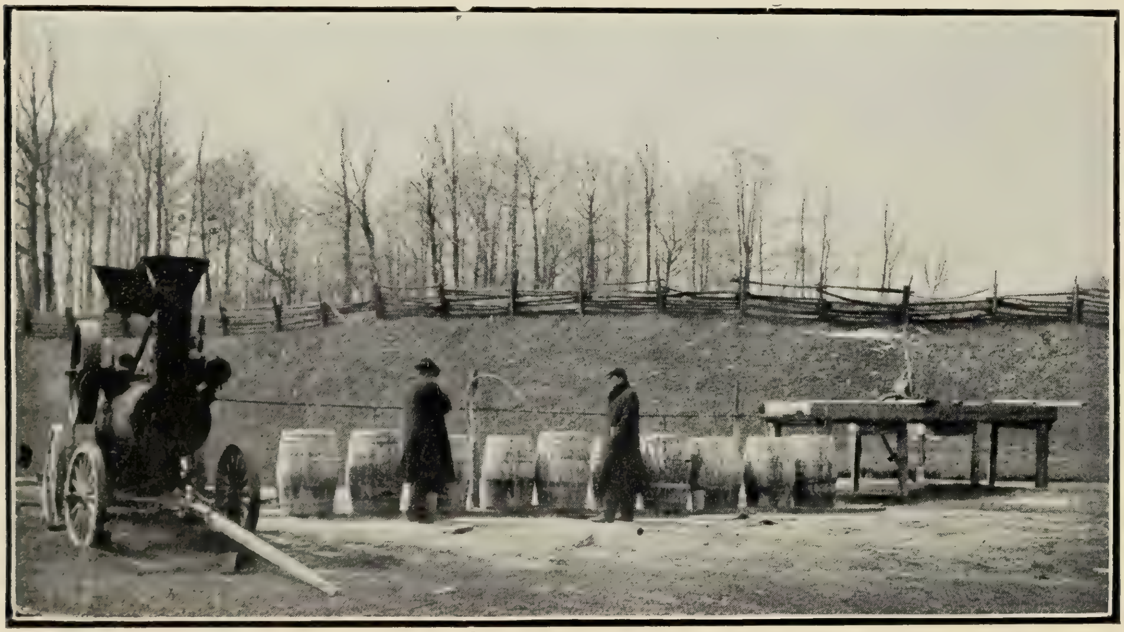


Fig. 9

Threshing engine used for boiling lime sulphur mixture.

From the above it will be noted that the discovery of lime sulphur was another big advance in the progress of spraying. But good as lime sulphur was as a fungicide, it had, as will be pointed out later, certain defects which caused a search for a still better fungicide.

ARSENATE OF LEAD

This insecticide has played a very great part in the control of almost all biting insects of the orchard. At first it was sold as a thick paste but, as this made thorough mixing in water slow, the manufacturers soon discovered a way of making it as a fine powder which could be shaken gradually into the spray tank while the machine was running.

Its chief merits are: (1) Up to the present it is the safest of all insecticides on foliage and fruit, rarely causing any damage to either. (2) It adheres better than Paris green or other arsenicals. (3) It is more effective than either Paris green or arsenate of lime in the control of codling moth and apple maggot. (4) It can be combined safely with lime sulphur or Bordeaux mixture. It is true that it makes a blackish sludge with lime sulphur which is somewhat objectionable, but really causes little trouble.

ARSENATE OF LIME

Shortly after the introduction of arsenate of lead, arsenate of lime (also called calcium arsenate) was put on the market as a substitute for arsenate of lead.

Its chief merits are: (1) It is cheaper pound for pound than arsenate of lead and this cheapness is increased by the fact that one pound of it contains almost as much arsenic as one and one-half pounds of arsenate of lead. (2) When used with lime sulphur it does not cause a black sludge whereas arsenate of lead does. (3) It kills some insects more quickly than does arsenate of lead.

Its chief defects are: (1) It is more injurious to the foliage than is arsenate of lead. (2) It does not adhere to the foliage and fruit as long as arsenate of lead. (3) It does not control codling moth and apple maggot as well as arsenate of lead.

These defects caused growers to prefer arsenate of lead as a rule to arsenate of lime, though a considerable number regularly use it in the pre-pink application, where it has given good satisfaction.

NICOTINE SULPHATE

This insecticide began to be used in Ontario about the year 1908. At first its use was chiefly against aphids but as the years went by it was found to be very effective also against the red bug, apple leaf hoppers and the pear psylla. It is somewhat costly. Fortunately it may be used in combination with any of the common spray materials.

SUMMARY OF SPRAY MATERIALS IN USE BY 1910

For biting insects	Arsenate of lead chiefly Arsenate of lime to a small extent Paris green, only with Bordeaux
For sucking insects	Lime sulphur for scale insects and blister mite Nicotine sulphate, chiefly against aphids of all kinds

For fungus diseases	Lime sulphur chiefly Bordeaux mixture to a lesser extent

THE PERIOD FROM ABOUT 1910 TO 1941

In this long period there has been no great crisis, such as that caused by the San Jose scale to give a great impetus to the development of orchard spraying. The periods before 1910 had placed spraying on a firm basis and since then progress was fairly steady and rather slow, though at times moderately rapid. Prices of fruit had something to do with spraying: a period of good prices always encouraged more and better spraying; a period of low prices led to less and poorer spraying.

DUSTING VERSUS SPRAYING

About the year 1914 much interest and high hopes were aroused by the substitution of dusting for spraying in certain localities in the United States. The dust used in most cases was a mixture of finely powdered sulphur and arsenate of lead. This was applied by a power blower. In the United States dusting had at this time a number of strong advocates. Their influence led to its being introduced into this province about 1915. A duster was much cheaper than a sprayer and could cover about 20 acres of large trees in a day—more than twice as many as could be done by any power sprayer at that date. It weighed less than liquid sprays and only a few minutes were required to fill the hopper. The dust apparently did no damage to the fruit or to the foliage and cost about the same as spraying. It was claimed to give just as good control of the common insects and diseases as spraying. Thus many growers became interested and a few at once invested in an outfit.

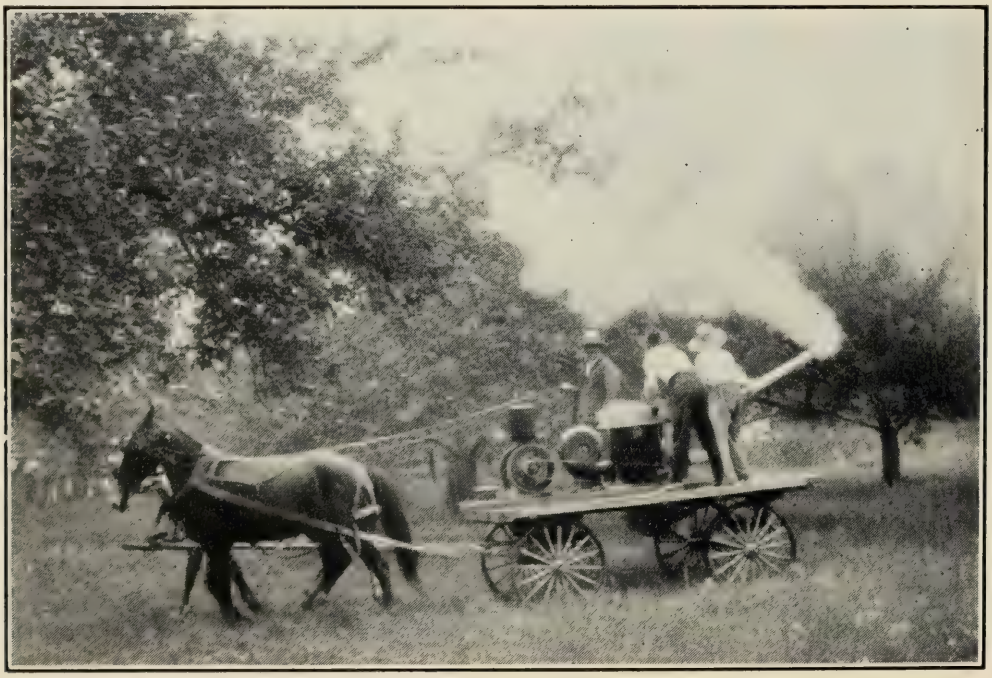


Fig. 10
Dusting large apple trees by a power duster.

In 1916 the Fruit Branch and the writer, seeing the need of tests as soon as possible, chose two orchards of large apple trees, one at Grimsby and the other in Prince Edward County. The writer dusted the former and W. F. Kydd of the Fruit Branch the latter.

In the Grimsby orchard more than 90% of the fruit was kept free from worms and scab. In the Prince Edward orchard the codling moth was well controlled but there was a high percentage of scab on Snow and other susceptible varieties. As the work in both cases was well done it was clear that under some conditions—apparently wet weather—dust would not control scab. Growers planning to purchase dusters were advised, therefore, to await further tests. Several growers, however, went ahead and bought. More outfits were sold the next year and a few the following year. It was only a few years, however, until everyone saw that in a wet season the dust did not control scab because the rain washed it off too quickly. They also saw that it could not be used against San Jose scale or oyster shell scale and some other insects. So all returned to the liquid spraying. Dusting with sulphur, however, has been proven to have a useful place in the control of brown rot on peaches, cherries and plums, especially if applied a short time before picking.

OIL SPRAYS

Not long after the discovery of lime sulphur, miscible oil sprays were put on the market. Scalecide was one of the most common of these. They gave good results against San Jose scale but were costly and often deteriorated in storage; so they never became popular in Ontario.

They were gradually superseded by lubricating oil emulsions. These were made from a cheap lubricating oil emulsified by one of several kinds of emulsifiers such as soap, Bordeaux mixture or calcium caseinate. In Ontario Bordeaux was used almost exclusively as the emulsifier in dormant applications. This emulsion was easy to make, cheap and relatively pleasant to apply. At first it was used at a 3% or 4% strength as an alternative spray to lime sulphur against the San Jose scale. It gave excellent results and on large trees controlled the scale better, as a rule, than did lime sulphur. This was largely because it spread more freely over the bark and therefore covered the tree better.

Later it was tested against the fruit tree leaf roller, a native insect that, since 1910, had become very destructive in a few orchards here and there over the province, and that arsenate of lead had failed to control. A 5% or 6% emulsion, applied before the fruit buds began to burst, destroyed the eggs of this insect and thereby controlled it.

When the red mite of plums became a serious pest of both plums and apples, a 3% oil emulsion applied at the same time as for the leaf roller killed the eggs of this pest also. The red mite is a very tiny, red spider type of creature and is not native but an importation from Europe. It was first identified in Ontario in 1912 and has now spread over the whole province and some years does much damage. It attacks chiefly plums and apples.

W. A. Ross of the Entomological Branch, Ottawa, in a series of experiments from 1924 to 1931 proved that a 3% lubricating oil emulsion was the most effective insecticide against pear psylla, the most destructive insect enemy of pears. It has to be applied very thoroughly to all pear trees in the orchard and also to other trees nearby in late March or early April. It controls partly by killing the adults on the bark and partly by acting as a repellent to egg-laying.

Ross also demonstrated that the above strength of the emulsion would control the black cherry aphis, if applied carefully just as the buds were ready to burst. This kills the newly-hatched young on the buds. Experiments several years later, however, have shown that dinitro-cresol 1½ lbs., in 100 gallons of a 2% calcium caseinate oil emulsion is an even better remedy. In all the above the emulsion was applied before the foliage had appeared because otherwise it would burn the foliage.

About 1930 in the United States it was found that an emulsion, made from a highly refined light oil with calcium caseinate or other emulsifier, could be used safely on apple foliage with arsenate of lead in cover sprays to control codling moth in heavily infested orchards. The emulsion is used at a 1% or ½% strength. It acts both as a sticker for arsenate of lead and as an ovicide. Such an emulsion, however, cannot be used with safety soon after or just before any sulphur spray, as burning of the foliage is likely to result.

About 1932 a tar distillate emulsion was put on the market for use chiefly against aphid eggs, but as the spray was both costly and very irritating to the operator's face and hands and to the horses, it never became popular.

The above material was soon followed by a proprietary mixture known as Elgetol. This has become fairly popular as a remedy for aphids and also bud moth. It too is used only as a dormant spray.

From the last few pages can be seen the need for and discovery of several important new sprays for certain types of insects that at times are very destructive.

THE APPLE MAGGOT PROBLEM

The apple maggot has presented one of the greatest insect problems with which the province has had to deal. This is because Great Britain in 1930 decided that apples shipped there must be 100% free from this insect; otherwise, in self defense they would have to place an embargo on shipments of apples from Canada.

This insect was of very little importance previous to about 1908, when it did much damage in several orchards east of Toronto. Further damage took place in the next two years. The writer, forseeing more trouble, began an investigation of the insect in 1911 and the following year W. A. Ross, who had just been put in charge of the Dominion Entomological Station at Vineland, joined in the investigation. Eight seasons' work was required before the insect's habits and life history were worked out and a satisfactory method of control discovered and thoroughly tested. It was found that arsenate of lead applied at the right times and to all the trees would kill all the flies in the orchard before they could lay eggs. This, however, would

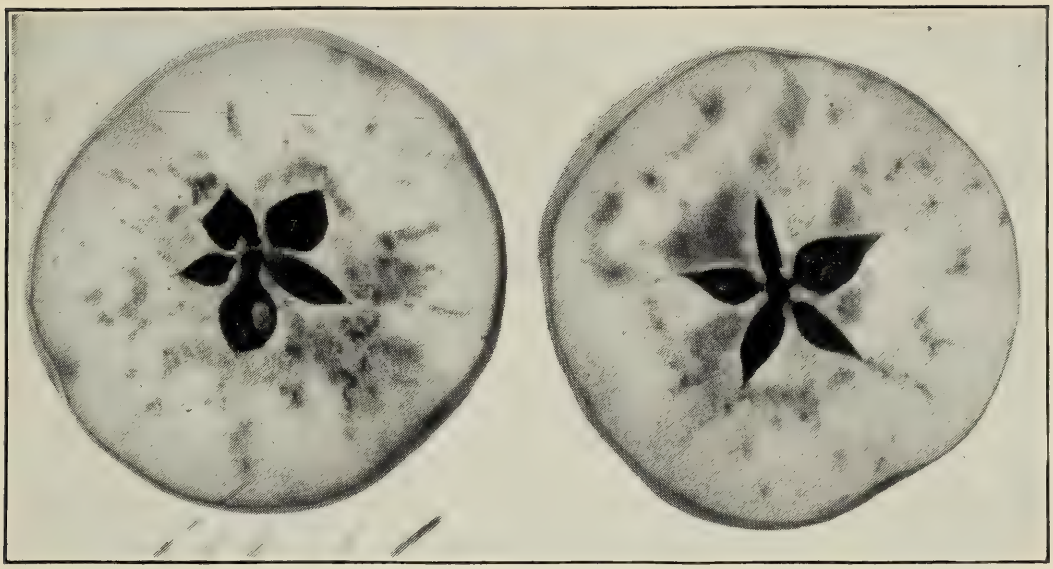


Fig. 11
Cross-sections of apples showing the work
of apple maggot.

not always give 100% control because, if there were any neglected apple trees or hawthorns within 300 yards of the orchard, flies ready to lay eggs would come from them and oviposit before being killed by the poison. Hence legislation was passed requiring that:—

1. The orchard of every grower intending to export apples be registered.
2. Every such orchard be sprayed in accordance with the directions of the Provincial Entomologist.
3. All wild or neglected apple trees and hawthorns within 300 yards of such orchards be cut down or sprayed in the same way as the orchard itself.
4. Inspectors be appointed to see that the above instructions are carried out.
5. In the fall of the year such registered orchards be inspected before fruit is harvested and, if any infested apples are found, the export of the fruit be not permitted.
6. The fruit be inspected again at packing time and, if free from apple maggot infestation a certificate for export be given.

The great difficulty lay in having the neglected apple and hawthorn trees cut down or properly sprayed. Moreover, occasionally a fly would come in from trees even more than 300 yards distant and infest the apples. Nevertheless in spite of these difficulties a large percentage of the commercial orchards qualified for export.

Some benefits, however, followed from the apple maggot work:—First, a large number of hawthorns were cut down and many neglected apple or crab trees destroyed; and second, the extra applications of arsenate of lead for the apple maggot helped towards better control of the codling moth, and, where a fungicide was added to these sprays, better control also of apple scab.

CHERRY FRUIT FLIES

There are two species of these flies. Both resemble closely the apple maggot fly and both have the same habit of puncturing the skin of the fruit with their sharp ovipositors when laying eggs in the pulp. Early varieties as a rule are very little attacked but Montmorency and Morello and also all late sweet cherries are sometimes so severely infested that they are almost totally ruined by the little white maggots feeding upon the pulp.

In the years 1914 and 1915 several fine cherry orchards in the Niagara district were so badly infested that almost all the fruit was ruined. None of the growers knew what insect was doing the damage or how to combat it until the writer told them. The writer and his assistant, George Spencer, seeing the need, began a study of the insects to find a method of control. The life histories of both species were studied and found to be very similar to that of the apple maggot. It was found also that arsenate of lead, if applied to all cherry trees, whether cultivated or wild, in and alongside the orchard, first just when Early Richmonds were beginning to turn red and again when Montmorencies were beginning to redden, would give almost 100% control. In the second spray it was necessary to omit the poison on early varieties because the date was too near picking time to use a poison safely.

THE CODLING MOTH PROBLEM

No orchard insect has been so widely and carefully studied in North America as the codling moth, and none found so difficult to control in districts favorable to its increase. There are, however, numerous orchards in the province where it can be controlled easily by two thorough applications of arsenate of lead, the first just after the blossoms have fallen and the second four weeks later. The last usually coincides with the first apple maggot spray.

It is in the Niagara district and Essex and Kent Counties, where the longer season and the greater heat make possible two full broods a year, that control is difficult. Occasionally it is difficult also in other areas in highly sheltered orchards where conditions are specially favorable. In all these areas several extra applications of arsenate of lead have had to be given, supplemented at times by a summer oil emulsion and nicotine.

Ross and his assistants have been studying the insect for many years and have observed also the control methods used in the United States. It is evident that a new and better insecticide is badly needed for this pest. Some think DDT will solve the problem but many doubt this. It will probably be several years before this can be determined definitely.

A great deal of the failure to control codling moth is caused by lack of thorough spraying, especially of large trees. On these the inner side of the fruit often is not covered by the spray and thus becomes infested by scab.

CHANGES IN FUNGICIDES

It has been stated earlier that by about 1910 Bordeaux and Paris green had given place to lime sulphur and arsenate of lead as the two standard spray materials. For about fifteen years they remained as such. Then it began to be observed that lime sulphur, though giving good control of diseases, was in some years, especially in hot weather, causing too much injury to the foliage. This took the form of dwarfing the leaves and more or less burning their margins. In very hot weather it sometimes also caused sun-scalding on the exposed side of the fruit. The leaf injury, which was the more important, was regularly much worse in unthrifty orchards. Heavy spraying also tended to increase the injury. As anything which injures foliage weakens the tree and results in lighter crops, it became evident that it was advisable to find a substitute for lime sulphur which would be both safe and effective and if possible as cheap. A search for such a substitute soon began both in Canada and the United States.

The most promising substitutes so far found are various derivatives of sulphur, such as very fine sulphur with a substance added to make it mix with water. Such mixtures are commonly called wettable sulphurs or microfine sulphurs. Another form of sulphur known as flotation sulphur has also been used. These all proved much safer on foliage than lime sulphur but none of them in wet weather protects the foliage and fruit as long as lime sulphur and consequently more applications have to be made. This, of course, increases the cost of spraying.

Several derivatives of copper have also been tested, of which Coposil is perhaps the best known. These also have considerable merit but have not become popular for fruit trees.

When it was discovered that lime sulphur was causing considerable injury, the spray leaders tried going back to Bordeaux for the delayed dormant and pre-pink applications. It was seen that Bordeaux gave excellent control in these two very important applications and caused, so far as could be seen almost no injury. Bordeaux therefore was specified in the spray calendar as a fungicide for the delayed dormant and pre-pink sprays and still remains there. It cannot, however, be used in the pink, calyx or first cover spray without danger of seriously russeting the fruit or causing dropping of foliage.

Another change made by many growers was to use half the usual strength of lime sulphur and along with it a wettable or other sulphur derivative in the hope that this would give good control and largely overcome danger of injury. This worked fairly well though at times there was a little injury.

Lime sulphur alone at the reduced rate of 1½ gals. to 100 gals. of water, which is about 60% the normal strength, is still being used by a considerable number of growers. The majority, however, today seem to be switching over to microfine sulphur or a flotation sulphur and shortening the period between applications.

From the above it will be clear that there is still need of a really reliable and safe fungicide as a substitute for lime sulphur.

SUMMARY OF SPRAY MATERIALS APPROVED IN 1895, 1910 AND 1944 RESPECTIVELY

INSECTICIDES

1895	1910	1944
Paris green	Arsenate of lead	Arsenate of lead
Kerosene emulsion (rarely used)	Arsenate of lime	Arsenate of lime
	Paris green (only with Bordeaux)	Nicotine sulphate
	Nicotine sulphate	Lime sulphur
	Lime sulphur	Oil emulsions
		Elgetol
		Dinitro cresol

FUNGICIDES

1895	1910	1944
Bordeaux	Lime sulphur	Lime sulphur
	Bordeaux mixture	Bordeaux mixture
		Lime sulphur at ½ standard strength plus a wettable sulphur
		Wettable sulphur
		Microfine sulphur
		Flotation sulphur
		Coposil

The above shows the increasing complexity of spray mixtures as the years go by.

FURTHER IMPROVEMENTS IN SPRAY OUTFITS

It has been pointed out already that the San Jose scale led to the manufacture of gasoline powered spray outfits. These at first were soon equipped with a much improved disc type of nozzle, often spoken of as the "Friend" nozzle. Even with these outfits it was very difficult to cover thoroughly large trees; hence some growers headed the trees back five feet or more so that they could reach the top. Others—the majority—built towers four to six feet high on top of the tanks and sprayed from them. This made good coverage easy but there was considerable danger to the operator, especially when branches interfered with the passage of the outfit.

The next stage was the introduction in 1916 of the spray gun. With this at a pressure of 200 to 300 lbs. the spray could be sent from the ground right over the tops of high trees, but to do so the gun had to be opened up and the liquid shot out as a coarse spray a foot or so in width. This meant that the operator had to be very careful and systematic or he would miss a good many branches or parts of branches. There was also more danger of burning with the lime sulphur than when lower pressures and a finer spray were used.

Soon after the single gun was introduced came the double gun. This was an improvement but required somewhat higher pressure for the best work.

The double gun and a pressure of 300 lbs. was followed by the so-called "broom" and 400 to 500 lbs. pressure. The brooms had 4 to 8 nozzles on a cross pipe about one foot long attached to the end of a pipe three to five feet long. The larger number of nozzles was for 400 lbs. pressure or higher. This type of outfit, sending out a cloud of fine spray which carried through the trees, made spraying both easy and rapid and left no excuse for missing any branches. While this is true, the writer has seen men who were thought to be good sprayers miss at least two feet of the top of many trees simply because they had become over-confident and did not realize they needed to watch carefully whether they were sending the spray high enough.

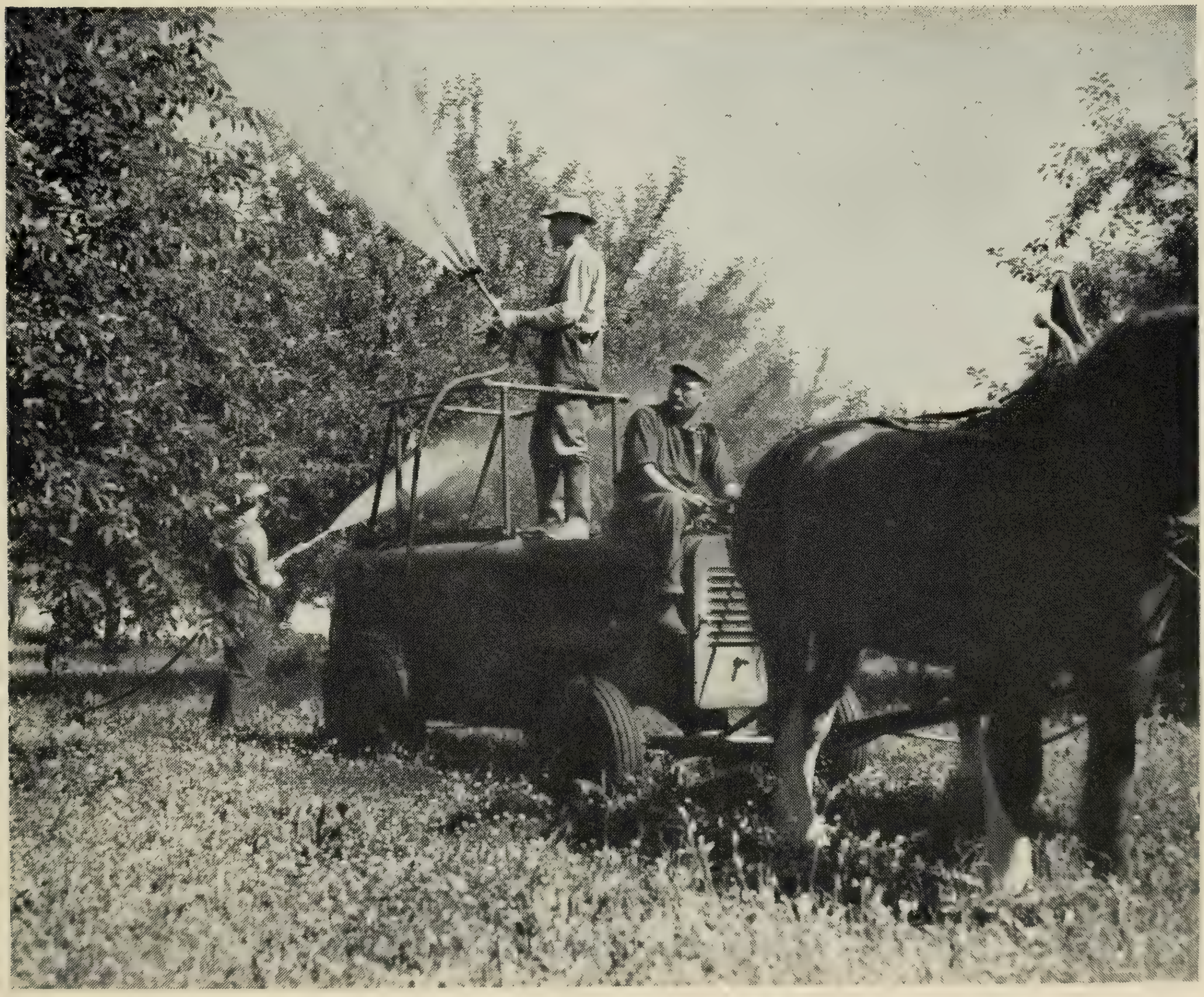


Fig. 12
Power sprayer equipped with a 4-nozzle broom and a single gun.

EXTENSION WORK AFTER THE SAN JOSE SCALE CRISIS

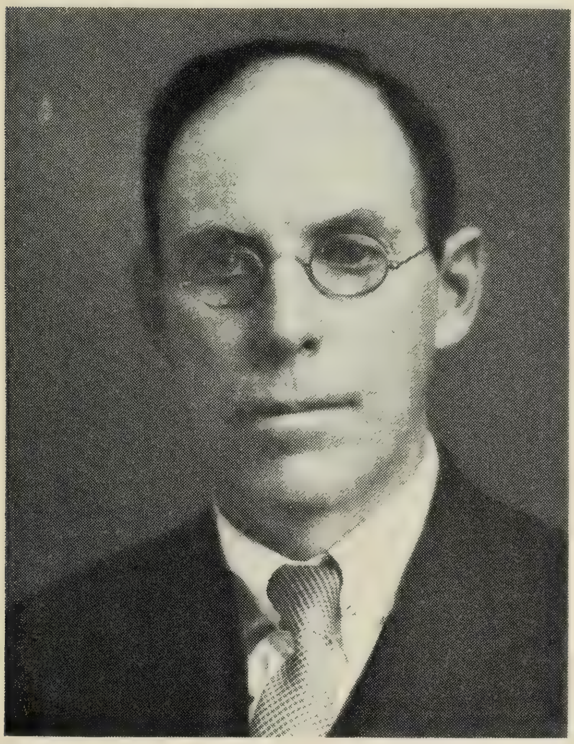
Up to 1924 the main purpose of extension work was to induce as many growers as possible having potentially good orchards to begin spraying without further delay. To accomplish this reliance was still placed chiefly on demonstration orchards in every district. Also for a few years a bonus was paid to beginners, but this was soon discontinued. The demonstration orchards after 1908 were selected by the Fruit Branch and sprayed by trained men employed by it. The local agricultural representative always took a great interest in these orchards and in several counties even supervised their spraying. In the fall of each year meetings were held in a number of the orchards. For instance, it is recorded that in 1912 there were 143 such orchard meetings in the province with a total attendance of 7,150. Many of the best growers of today owe their success to the influence of these demonstration orchards. A striking example is W. L. Hamilton of Collingwood, the champion prize winner for apples in Canada and the British Commonwealth.

Several other factors played a part in extension work and helped to make it more effective: First was the establishment of the Provincial Fruit Branch in 1907 with Mr. P. W. Hodgetts as director. This branch did a very important work. It was responsible for the demonstration orchards and assisted in almost every other aspect of extension.

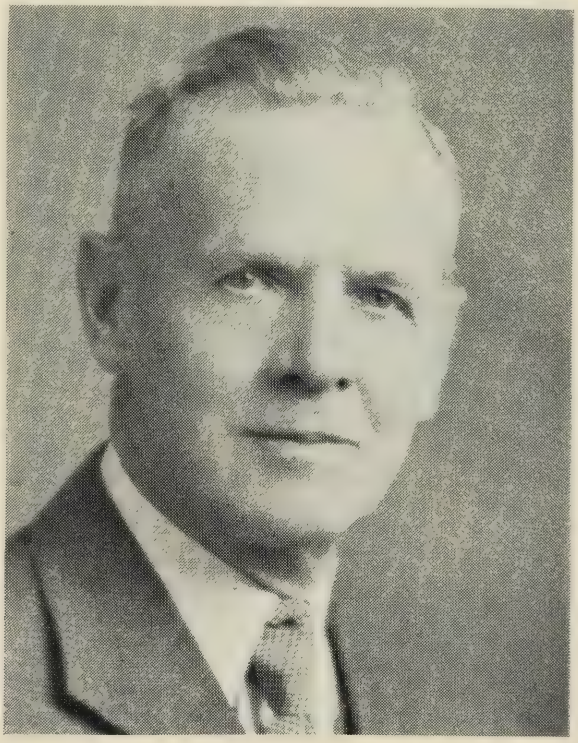
P. W. Hodgetts, Director, Fruit Branch,
Toronto.

Next came the Agricultural Representatives whose duties were largely of an extension character and who therefore were interested in spraying as an aid to fruit growing. Ever since the year 1907 these men have been an important factor in the progress of spraying.

Next in order was the Ontario Agricultural College at Guelph, through J. E. Howitt, Professor of Botany, and L. Caesar, Provincial Entomologist and Professor of Economic Entomology. These men have taken a great interest in extension work for more than 30 years. They have given addresses at almost every important fruit meeting and taken part in the discussions. They also supervised the provincial spray service since its inception in 1924 and have been active in many other ways.



J. Eaton Howitt, Professor of Botany, Ontario Agricultural College, Guelph.

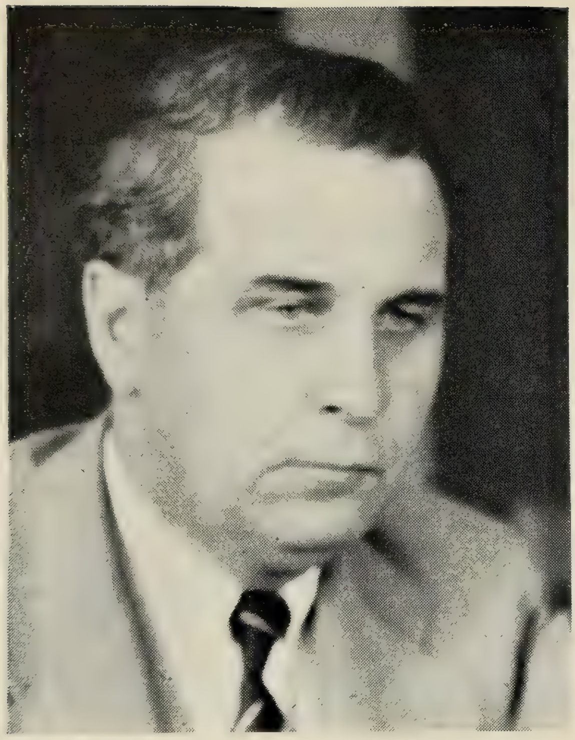


Lawson Caesar, Provincial Entomologist and Professor of Economic Entomology, Ontario Agricultural College, Guelph.

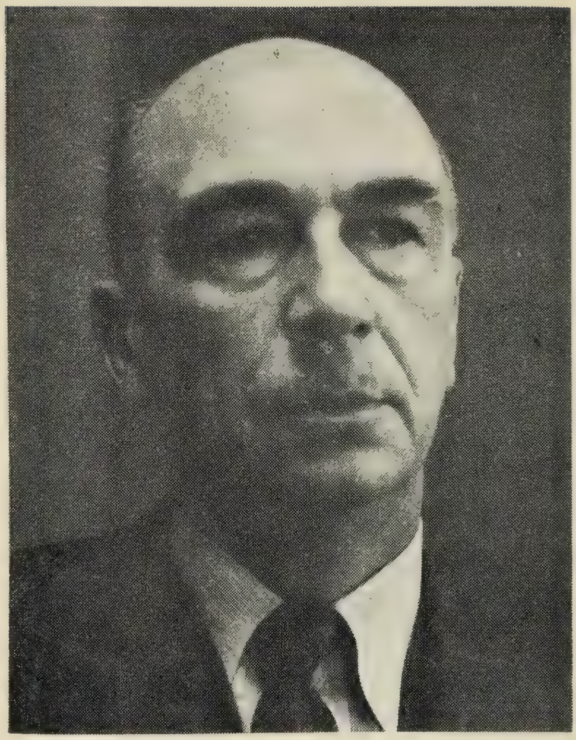
The Dominion Entomological Laboratory at Vineland, under the charge of W. A. Ross and a substation at Simcoe under Allan Hall, and also the Dominion Laboratory of Plant Pathology at St. Catharines have contributed much to extension, though their main function is research.

In addition to all the above there was the work done by the heads of the various fruit growers associations, especially in districts where cold storage buildings had been erected. Such men as Jas. E. Johnson, and Geo. Wilson in Norfolk, Geo. H. Laird in Oxford, and several others were all intensely interested in spraying and did much to further it.

There was also another factor that many overlook; namely, the spray companies of the province. These men from the very nature of their work were anxious to promote more and better spraying and played an important part in bringing this about.



William A. Ross, in charge of Dominion Entomological Station, Vineland Station, and later Chief, Fruit Insect Investigations for the Dominion.



Dr. G. H. Berkeley, Senior Pathologist in charge of Dominion Laboratory of Plant Pathology, St. Catharines.

THE SPRAY SERVICE

Down to about 1924 extension work was aimed to a very large extent at inducing more growers to spray. The writer believes that it is safe to say that by 1924 there were very few men who would not admit from what they had seen that it was no longer possible to grow fruit, especially apples, successfully without spraying. This being so, extension work from then on was directed chiefly to improving the way in which the spraying itself was being done, because a careful observer visiting numerous orchards could not help but see that, while the fruit in many was beautifully clean, in others it was the reverse.

Not more than about 50% of the spraying could be said to be good. The big problem, therefore, was how to induce the poor sprayers to become good or at least moderately good sprayers.

During the First Great War many growers, believing that they could make more money by raising grain and livestock, had neglected their orchards. Some years after the war when the price of grain and livestock had fallen greatly, these men turned again to their orchards in the hope that they would pay better.

In 1924 the attendance at fruit meetings was remarkably large and the attention paid to the addresses, especially on spraying, almost intense. It was easy to see how deeply in earnest the men were and how anxious to succeed. The writer, observing this and knowing that unless something were done to improve the character of the spraying, a large percentage of the growers would, as before, fail to secure clean fruit and would therefore become discouraged, decided to try out a plan of personal supervision of their spraying. Accordingly, with the hearty co-operation of Frank C. Paterson, the local agricultural representative, he chose eight apple orchards between Bowmanville and Cobourg and offered to supervise all the spraying in these himself, if the owners would agree to carry out his directions as well as they could. This they gladly agreed to do.

There is not time to go into details of this further than to say that the faults in their spraying were pointed out and corrected, with the result that the men, seeing that they were really doing a good job, entered more whole-heartedly into the work and enjoyed it. Supervision of the spraying in these orchards was continued until all the applications had been given. In the fall an orchard meeting was held in one of the orchards and was well attended. The result was that the neighbouring counties all asked that the service be extended to them.

Their request was made known to the Fruit Branch and the Minister of Agriculture and, as both readily approved, the system of demonstration orchards was then abandoned and replaced by what has been called the "Provincial Spray Service". Two years later this service was extended to almost every commercial orchard in the province, except the Niagara district, which had by this time a service of its own.

Prof. Howitt and the writer were put in charge of the Provincial Spray Service as superintendents. For each district one or more local supervisors, paid by the province, were appointed. The Agricultural representative in each county undertook to mimeograph and send out promptly to the growers the spray letters prepared for each application by the superintendents, and also a warning notice and a spray calendar early in the season. Each grower was required to agree to follow directions to the best of his ability. The local supervisors were instructed to visit every such grower and try to get him to do his work promptly and well.

Each year before the spraying season opened all the supervisors were called to Guelph and given a two-day course to prepare them better for their work and to increase their interest in it. At this course the most important insects and diseases were briefly discussed, the timing of applications explained, and questions on spray materials answered. Half a day or more was spent in the orchard training the men in the technique of spraying and in discussing mistakes and how to remedy them. As questions on bridge-grafting and pruning were sure to be asked by the growers, some practice was given in each of these. There was also a discussion on fertilizers.

There is no doubt that the service did a great deal for fruit-growing and, although somewhat costly, would have been continued for many years had it not been that the great depression which came about in the thirties forced the government to curtail greatly expenses and to dispense with the services of all the local supervisors except four, who were each given a much greater area to supervise as well as they could. Since that time there has been relatively little personal supervision of spraying and the service has been conducted largely by spray letters prepared by Howitt and Caesar or later by Howitt and Thompson, and mimeographed and sent out by the agricultural representatives to the growers. A spray calendar, as before is sent out at the beginning of the season to help still further in determining the time of application for each spray.

Robert W. Thompson, Provincial Entomologist and Professor of Economic Entomology, Ontario Agricultural College, Guelph.

In the same year (1924) in which the writer initiated the Provincial Spray Service, Dr. G. H. Berkeley of the Dominion Laboratory of Plant Pathology at St. Catharines initiated a service for the Niagara district. This was similar to the above service except that there was less personal supervision of the work of the individual growers.

This Niagara Service is still operating but is now conducted by the Horticultural Experiment Station, Vineland Station. Mr. C. B. Kelly is in charge and is assisted by W. A. Ross and G. C. Chamberlain, who act in an advisory capacity as representatives of the Dominion Entomological Station at Vineland and the Dominion Laboratory of Plant Pathology at St. Catharines.

RESEARCH

Just as progress in the control of human diseases and parasites depends upon medical research, so progress in orchard spraying depends very largely upon research on the insects and diseases of the orchard and on insecticides and fungicides. Such research is carried on chiefly by entomologists, plant pathologists and chemists. Engineers, too, have made a big contribution through great improvements in spray machinery.

Progress during the first twenty years, 1890 to 1910, had been greatly hampered by lack of trained men who could devote the time necessary to solve the problems that arose. Dr. Saunders, Dr. Fletcher, Prof. Craig, Prof. Panton and Prof. Lochhead all did much to help, but they all had so many other duties that they could give only a small fraction of their time to spray matters. By 1910 Fletcher and Panton were dead, Craig and Lochhead had moved from Ontario to new positions, and Dr. Saunders was no longer able to help. It therefore became clear both to the fruit growers and to Federal and Provincial Departments of Agriculture that trained men, who could give more of their time to research and leadership, should be appointed.

In 1908 Caesar was added to the staff of the Department of Entomology at the Ontario Agricultural College chiefly for the above purpose and in 1912 was made Provincial Entomologist.

In 1911 the Federal Department of Agriculture established a laboratory for the study of fruit insects at Vineland and placed W. A. Ross in charge.

The above two men from 1911 to 1940 had charge of practically all the research on orchard insects. In 1940 Caesar was superannuated and was succeeded by his chief assistant, Prof. R. W. Thompson.

Research on fruit diseases has been under the charge of Prof. Howitt, Department of Botany at the Ontario Agricultural College, Guelph, since 1908, and by Dr. G. H. Berkeley, Head of the Dominion Laboratory of Plant Pathology at St. Catharines since 1912—the year in which this laboratory was established.

As the years have gone by the above leaders have all been given assistants, and today, instead of there being only four men in all engaged in research there are four provincial and twelve federal men giving much of their time to this work. It will be evident therefore that since about 1910 there has been much more research done than previously. This means that we have now a much better knowledge of both the insects and diseases and how to combat them.

PUBLICATIONS

As a result of their researches the entomologists and plant pathologists have been able to publish many helpful bulletins and circulars. These deal with almost every important insect and disease of our orchards. The publications have been distributed free of charge by the Departments of Agriculture at Ottawa and Toronto and by the local agricultural representatives. They are of value to spray supervisors, field men, agricultural representatives, students of agriculture, teachers and, of course, to the fruit growers themselves.

SPRAY CALENDARS

Of all the publications on spraying none was more important and essential than the spray calendars sent out to the growers from year to year. At first all of these were drawn up by Craig and Fletcher of the Central Experimental Farm, Ottawa. The first calendar for both insects and diseases seems to have been published about 1891. This was revised from time to time by the same men down to the year 1897 when Craig resigned as Horticulturist. His successor W. T. Macoun then assisted Dr. Fletcher in the revision of the Calendar for several years.

The first calendar published by the Province of Ontario was prepared in 1892 by Prof. Panton the Biologist of the Ontario Agricultural College, Guelph. This was revised by him in 1895.

In 1902 Prof. Lochhead, Panton's successor published a calendar for all orchard fruits and another in 1905 for apples alone.

For several years after this there seems to have been a dearth of calendars, and many of the growers seem simply to have watched what the best sprayers were doing and followed their lead. This dearth seems to have been the reason for the Fruit Branch in 1909 sending out a circular written by three good fruit growers, James E. Johnson, of Simcoe, Dan Johnson, Forest and J. C. Harris, Ingersoll. In this circular each grower told what his practice was and to what he attributed his success. This circular is said to have helped many growers. In 1912 Caesar published his first Calendar. A year or two later Howitt became joint author and a little later Ross and Berkeley shared in the work. Hence for the last twenty years or more the calendars have been jointly revised annually by Provincial and Dominion leaders in the study of insects and diseases.

It is of interest to know that no new spray mixture, especially no fungicide is recommended in the calendar until it has first been carefully and extensively tested for 5 years. This is because weather conditions vary so much from year to year that shorter periods would often be unreliable.

WHAT OF THE FUTURE

This history covers the period from about 1885 to 1944 but does not include the years 1945 to 1948, the date of publication. This is because the writer felt that a new era in spraying had begun about 1945.

The first step in bringing in the new era was the coming of DDT. This is probably the greatest insecticide ever discovered. It was found by a synthetic process, and almost at once the chemists saw that here was the key to the discovery in the future of new insecticides and fungicides. The result is that in the last three years several new synthetic insecticides have been produced, some of them of great merit. So the future seems to have a bright prospect for progress in both insecticides and fungicides.

Another thing that suggests a new era is the great progress taking place in spray machinery. Already airplanes, helicopters and fog producers are being tested and giving great promise for the future. There seems no doubt that the advances in machinery are largely the outcome of the ingenuity that was developed and stimulated by the last great war. As, I believe, we are entering upon a new era of rapid progress there will be great need of well trained practical leaders with good foresight and sanity.

CONCLUSION

In concluding this history the writer regrets that though he wanted to give the names of the growers in the pioneer days of spraying who acted as leaders in their respective districts and did much to forward the movement by their examples and advice, he felt it unwise to do so because many names would have been missed and it would have seemed to be unfair to give credit to some growers and not to all.

There are, however, a few field men or supervisors who have done so much for the province that their names are given. They are W. F. Kydd, Leslie Smith, W. L. Hamilton, H. Morley Webster, Ira Ronson, Hubert N. Webster, Alex Goldie, G. C. Chamberlain and C. B. Kelly. Others too served well but not for so long a period.

This writer is much indebted to George Wilson, Director of the Fruit Branch, Toronto and to Prof. Robert Thompson, Ontario Agricultural College, Guelph, for the interest they have taken in this publication and for reading the manuscript and making helpful criticisms and suggestions.

We regret that since the manuscript was written Prof. Thompson, who was the writer's successor as Provincial Entomologist and Prof. of Economic Entomology at the College has died. His death is a great loss to the province for he had taken a very active interest in the work and had the respect and confidence of the fruit growers.

SOIL MANAGEMENT
AND
FERTILIZER USE

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RECOMMENDATIONS OF

THE ADVISORY FERTILIZER
BOARD FOR ONTARIO

GOOD SOIL MANAGEMENT IS THE KEYSTONE OF SUCCESSFUL FARMING

Published by Authority of Honourable T. L. Kennedy, Minister of Agriculture

ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 463 **JANUARY, 1949**

THE ADVISORY FERTILIZER BOARD FOR ONTARIO

WAS CONSTITUTED BY ORDER-IN-COUNCIL OF THE ONTARIO GOVERNMENT, APPROVED BY THE HONOURABLE, THE LIEUTENANT-GOVERNOR, DATED FEBRUARY 9TH, 1934

The functions of the Board are:

(a) To bring together in conference from time to time farmer-users, government officials and manufacturers in order to discuss problems of fertilizer usage.

(b) To examine experimental data from all reliable sources having to do with the use of fertilizers and methods of application, and to make recommendations as may be justified by such data or by approved farm practice.

(c) To encourage methods of soil management and cultural practices designed to increase productivity of Ontario soils.

(d) To give due publicity to the recommendations of the Board, so that farmers may be encouraged to use recommended fertilizers in the most effective way.

FERTILIZER ANALYSES, 1949

RECOMMENDED BY THE ADVISORY FERTILIZER BOARD FOR ONTARIO

GENERAL FERTILIZERS:

0-16-8
0-12-12
0-12-20
2-8-16
2-12-10
2-12-16
2-16-6
3-12-16
3-18-9
4-8-10
4-12-6
4-12-10
5-10-13
10-6-4

TOBACCO:

2-10-8
2-12-10
3-10-8
4-8-10
5-10-13

MATERIALS:

Ammonium nitrate, 33.5% N.
Ammonium phosphate, 16% N. and 20% P_2O_5.
Ammonium phosphate, 11%, N. and 48% P_2O_5.
Borax.
Copper sulphate.
Cyanamid, 20% N.
Muriate of potash, 60% and 50% K_2O.
Nitrate of soda, 16% N.
Potassium nitrate, 14% N. and 45% K_2O.
Potassium sulphate, 48% K_2O.
Superphosphate, 20% P_2O_5; Double superphosphate, 40-50% P_2O_5.

In addition to the above the following mixed fertilizers are approved for sale in 1949, although not included in the specific crop recommendations:

0-14-7 2-12-6 9-5-7

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Professor and Head of the Department of Soils, Ontario Agricultural College, Guelph

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Dr. P. O. Ripley, Field Husbandry Division, Experimental Farms Service, Ottawa

D. S. Blair, Horticultural Division, Experimental Farms Service, Ottawa

H. F. Murwin, Superintendent, Dominion Experimental Station, Harrow

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Two representatives appointed by the Ontario Crop Improvement Association, Toronto

Alex. M. Stewart, Ailsa Craig
Dr. L. H. Newman, Merrickville

Two representatives appointed by the Ontario Fruit and Vegetable Growers' Association, Toronto

Ross E. Peart, Aldershot
John L. Smart, Collingwood

One representative appointed by the Allied Florists and Growers of Canada Inc., Toronto

C. I. Delworth, Weston

One representative appointed by the Ontario Flue-Cured Tobacco Marketing Association, Simcoe

J. K. Perrett, Simcoe

and the following representatives of the Fertilizer Trade

E. K. Hampson, Manager for Canada, American Potash Institute Inc., Hamilton
Alex. T. Sinclair, North American Cyanamid Ltd., Toronto

and four representatives appointed by the Plant Food Producers, Ontario

Earl M. Grose, Chairman, Plant Food Producers, Toronto
Donald McKenzie, Member, Plant Food Producers, Ingersoll
E. R. Olsen, Vice-Chairman, Plant Food Producers, Toronto
Alex. Mooney, Secretary, Plant Food Producers, Toronto

"I conceive that the land belongs to a vast family of which many are dead, few are living, and countless numbers are still unborn."

Ascribed to an African (Nigerian) Chief.

"Man's living is derived from the soil alone, and as long as people and soil survive, the real sources of civilization survive."

Elmer T. Peterson of the Daily Oklahoman.

"The Soil is the Heritage of our Nation. We, who call ourselves the Owners of the Soil are only its Custodians for a brief span of time. The soil is our most priceless possession and our greatest responsibility. Freedom has never flourished in a hungry and impoverished land. God grant us the intelligence to respect the soil, and the Will to conserve it in all ways, so that when our period of Stewardship is done, we may pass on the Soil, with its Fertility and Fruitfulness undiminished. Thus, our children's children and their children's children shall not know Want. . . ."

Charles E. Sweet, Farmers' Digest, November, 1948.

". . . Our (world) record shows that we have ruined, for further practical cultivation, about one-fifth of our original area of tillable land. A third of what remains has already been badly damaged, another third is highly vulnerable, and the erosion process is still going on. When the world was younger and our population much smaller, we could, perhaps, stand such waste, but that time is past.

". . . The United States is somewhat better off, from the standpoint of productive land, than most nations. Even though we have ruined more good land in less time than any other nation in recorded history, we had the advantage of an unprecedented supply to begin with. Now we have little margin left, but we still have enough productive land if we take care of it. We cannot hope to maintain our present standard of living if we lose much more; eventually, if the losses should continue, the Nation would suffer even more seriously."

Dr. H. H. Bennett, Chief, Soil Conservation Service, U.S.D.A.

SOIL MANAGEMENT
and
FERTILIZER USE

"The nation's natural resources — land, lakes and streams, forests and mines — exist for the benefit of all its people. Not the least among these resources are our soils, the very foundation of . . . a permanent agriculture. A flourishing agriculture is the back bone of prosperity and social and economic progress in this country. It is a matter of some consequence as to what we are doing about this most fundamental of all resources, the soil. Are we merely farming the land for to-day or are we conserving to-day's soil for to-morrow."

Prof. G. N. Ruhnke, Director of Agricultural Research in Ontario.

SOIL SENSE

Origin and Nature of Soils

An adequate knowledge of the nature and composition of soil is necessary to a better understanding of its management.

What is soil? Soil as a whole is simply a mixture of solids, liquids, and gases or air. The solid portion consists of weathered rock (inorganic) plus organic material from living things such as roots and plant parts generally, and soil organisms. In this solid portion particles range in size from stones and gravel, through sand and silt, to clay. "Texture" of soil is determined by the proportion of particles of different sizes.

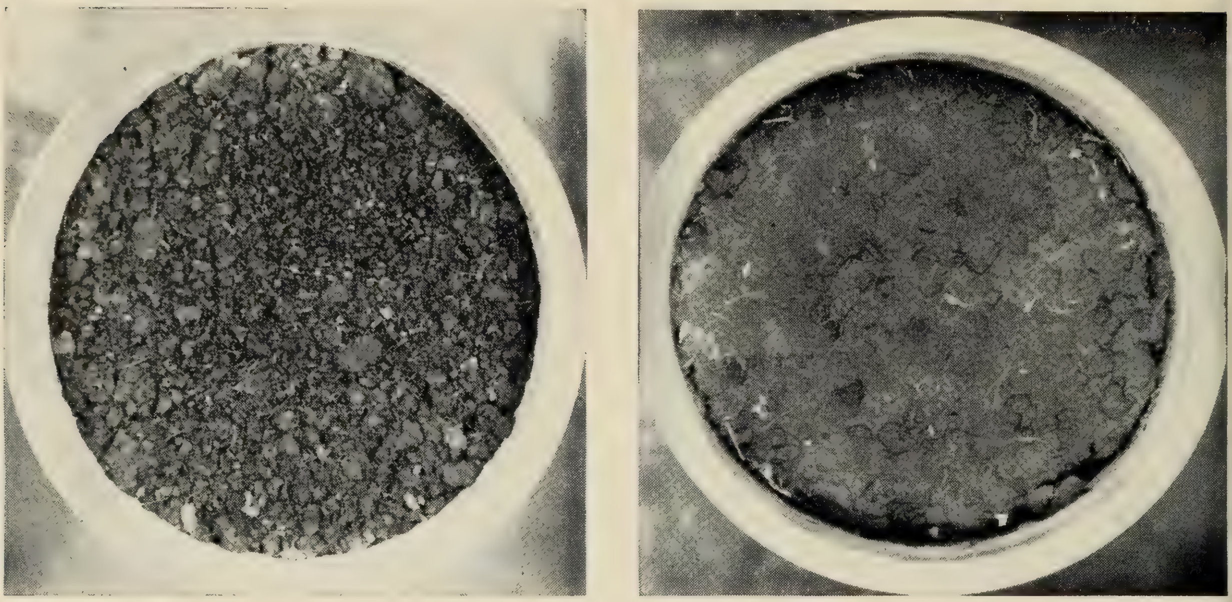
These particles cling together in groups, and it is the sizes and shapes of these groups and their resistance to breaking down, which make the "structure" of the soil. This in turn affects soil productivity since it determines the ease of root penetration, the rate of absorption and movement of water, and aeration. A satisfactory "granular" soil structure is as important in plant growth as proper balance of plant foods. In fact nutritional deficiencies are, in general, easily remedied, but fundamental soil characteristics, once disturbed, are repaired with difficulty.

Soils vary in colour depending upon the amount of organic matter present and the accumulation of certain chemical compounds. The darker soils are considered the most fertile, ranging through to the yellow, grey, and white which are the least fertile.

Aeration and Drainage

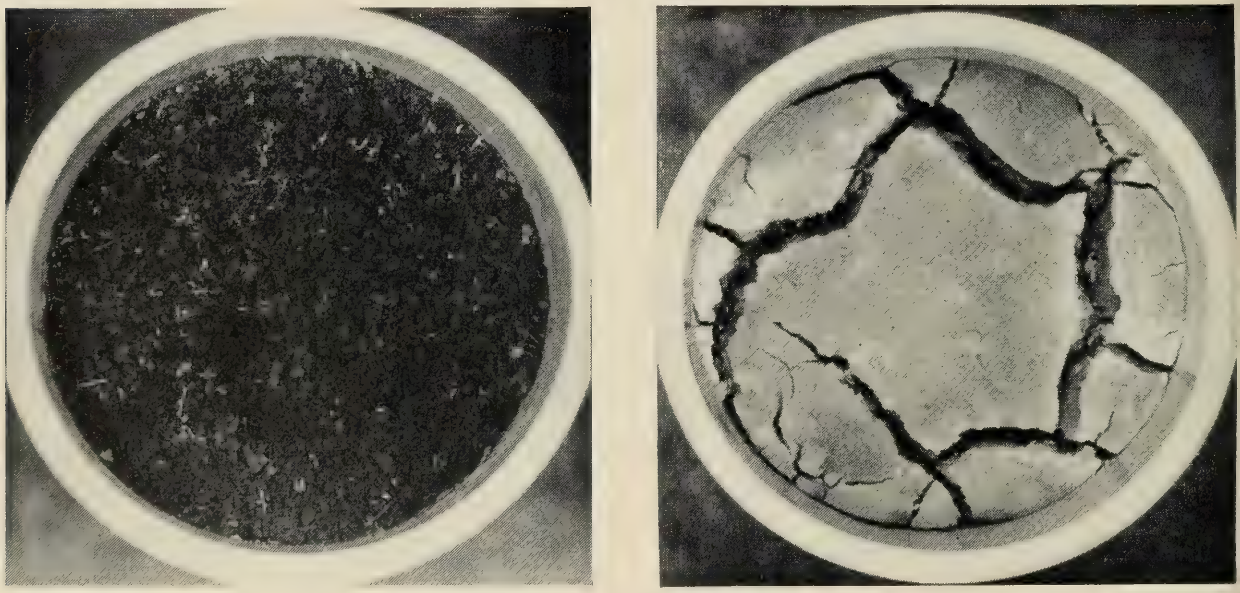
These are closely related and equally important since plant roots require air as well as plantfood in solution. Under-drainage improves many soils, and may be absolutely necessary to fit some for crop production. Naturally well-drained soils are granular in structure and usually well aerated. Compact, impervious soils, lacking satisfactory granular structure, drain poorly and are poorly aerated. Soils well drained, naturally or tiled, warm up early and are ready for cultivation and planting in the spring, before poorly drained soils.

FIG. 1. ORGANIC MATTER IS THE KEY TO GOOD SOIL STRUCTURE



This soil has been in sod for years, hence is well supplied with organic matter, and has an open crumb-like structure that is not broken down even by beating rains.

Originally similar soil to that on the left, but from an adjoining field where the organic matter has been depleted by faulty management and the physical condition is very poor. You don't dare work this soil right after rains.



This well granulated, humus-rich soil, when wetted, absorbs the water readily, drains freely, yet acts like a sponge to hold a store of moisture for the crop when it needs it.

When rain hits this soil, the top layer runs together like slurry. After the sun has baked it for a few hours, it sets like concrete, and then cracks into blocks. When heavy soils are exhausted of their organic matter they are "balky" soils to work, wet or dry.

Organic Matter

Definition — Soil organic matter, often loosely called "humus", is composed of plant and animal matter undergoing decay. The terms "soil organic matter" and "soil humus" are not easily defined or indeed capable of exact definition. However, soil organic matter may briefly be regarded as including such material (the main source) as dead roots, leaves, fruits, and stems of plants; carcasses of insects, worms and animals; live and dead soil micro-organisms; and various products of decomposition of dead residues. Chemically it consists of proteins, carbohydrates, fats, resins, waxes and similar compounds. Humus represents an advanced stage in the decomposition of organic matter.

Effects — Organic matter tends to bind loose soils, open up heavy soils, and increase the water-holding capacity of all soils. It constitutes the home and food supply of soil micro-organisms, including the nitrifying organisms. In decomposing it liberates nutrients which are then available to the plant, and reduces the loss by leaching of these nutrients. Organic matter also retards the loss of valuable topsoil by erosion.

The relationship of organic matter in the soil to the soil's capacity to retain moisture is frequently of vital importance. During the critical period of growth for most crops, for instance the period from flowering to filling of seed or fruit or tuber, there occurs the maximum call upon the soil for moisture. To meet this demand, soils, to be productive, should be adequately supplied, and kept supplied, with organic matter.

Sources — Primary sources are manure (see page 11), green-manure crops (see page 43) both legume and non-legume. These sources of organic matter often may be supplemented to advantage with old or spoiled hay, straw, and other crop residues. In general farming the practice of leaving cereal straws on the field is increasing. Other crop residues such as roots and weeds also add organic matter. In many sections, fruit and vegetable growers find it difficult to obtain the large amounts of manure necessary for their type of farming and must make use of substitutes as old hay and straw, and crop residues.

Treatment of dry organic-matter supplements — When using non-legume hay or straw, it is essential to add to each ton of this material 75 pounds of ammonium nitrate, or equivalent amounts of sulphate of ammonia or cyanamid. Apply broadcast on top of the hay or straw before disking or plowing. Six tons of dry hay or straw per acre should be the maximum application at any one time. More than this will be difficult to handle. (Six tons of either hay or straw will add as much organic matter to the soil as twenty tons of average manure.) Alfalfa and clover hay or straw are to be preferred as they contain sufficient nitrogen to bring about quick decomposition with some slight surplus for crop growth. It is highly desirable to *trash-disk all organic supplements* including green-manure crops, crop residues, and manures, partly incorporating the material in the topsoil, before completely burying it by plowing or heavy disking.

Legumes

For centuries the legumes have been valued as feed for man and beast. More recently their value as soil improvers is being recognized. Well-known members of this family are: alfalfa, clovers, soybeans, peanuts.

They have the common faculty of using the free nitrogen of the air, and through the media of certain bacteria the nitrogen thus gathered may be synthesized by the plant or stored in nodules on its roots. Legumes constitute the world's cheapest source of nitrogen.

In addition, many legumes are deep-rooted, penetrating and aerating subsoil areas which might otherwise become compact and impervious to either air or water.

FIG. 2. The soybean is a legume. Other legumes are alfalfa, clover, beans, peas, vetch. These crops are very valuable both as soil improvers and as food for man and beast.

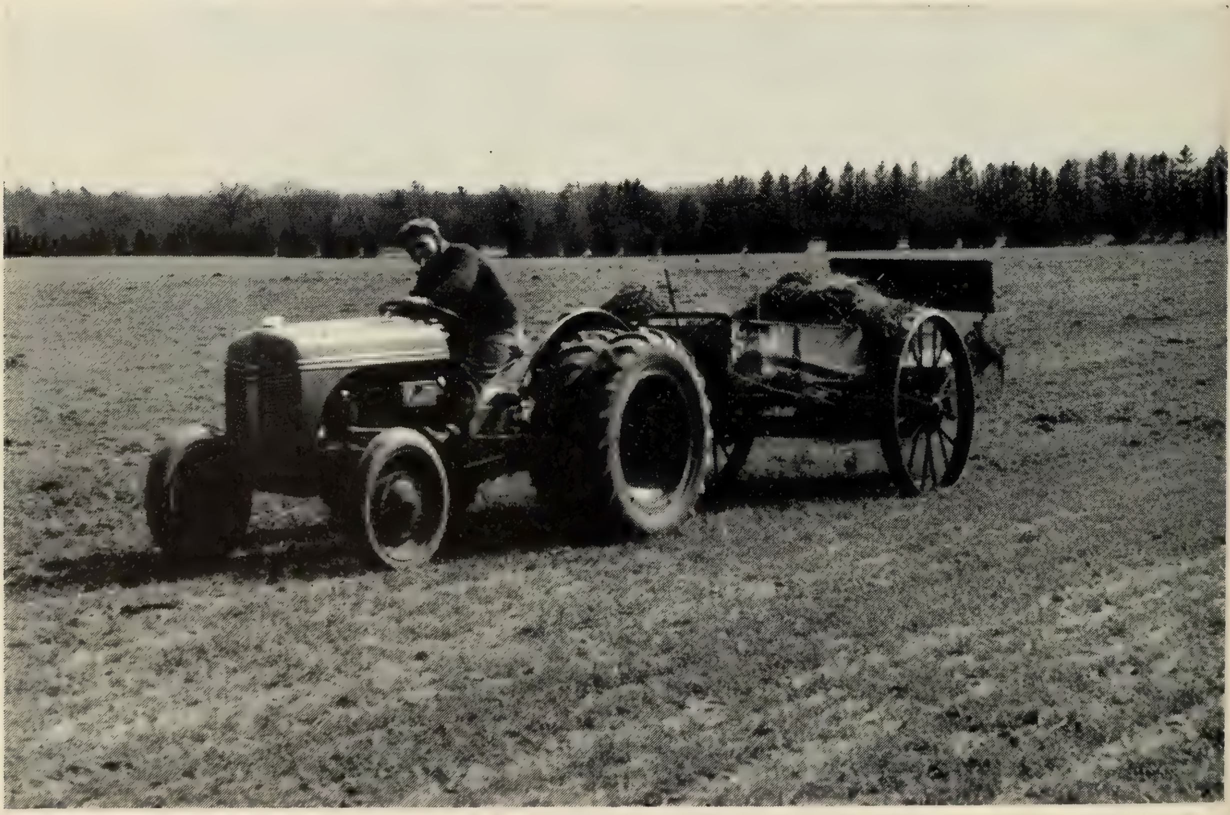


FIG. 3. Manure is still one of the most effective sources of organic matter. Use it on your own farm.

They are among the most useful of plants as a source of organic matter. Good crops of alfalfa or sweet clover may provide 3 to 4 tons (air-dry weight) per acre of good protein roughage for livestock, and still leave a residue of stems and roots comprising fully one-third of that amount, and containing 100 to 150 pounds of nitrogen. For cover crops and for green-manuring purposes, the legumes have few equals and fortunately most soils in Ontario are well suited for legume production.

Valuable as they are for soil-building purposes, it should be remembered that legumes are heavy feeders and to grow them satisfactorily the levels of lime, phosphate and potash should be high.

Manures

Plantfood value — Manure annually produced on Ontario farms contains many millions of dollars worth of nitrogen, phosphoric acid and potash. One ton of average farm manure contains approximately 10 pounds of nitrogen (N), 5 pounds of phosphoric acid (P_2O_5), and 10 pounds of potash (K_2O).

Care of manure — Putting manure back on the land is the natural means of returning to the soil as much as possible of the fertility removed by crops. Some loss of plantfood is inevitable in the making and handling of manure, but every precaution should be taken to reduce this loss to a minimum. Since more than one-half the nitrogen and at least three-quarters of the potash is contained in the liquid portion of the manure, the stable floor should be water tight, and enough litter or bedding should be used to completely absorb the liquid and prevent loss by seepage.

The sooner manure is spread on cultivated soil and worked in the less chance there is for loss. If piled for six months there is normally a 50 percent loss in plantfood. If the manure is accumulated in the yard, or stored for a time, it should be kept compact and reasonably moist to reduce losses by fire-fanging or excessive fermentation. Manure heaps exposed to the action of heavy rains, causing run-off from the yard, lose large amounts of available nutrients by leaching. Open manure-yards should not be located on slopes and should have no drainage. Manure sheds, covered pits, or yards with concrete floor and walls, are recommended.

The more intensive the cultivation program (as for vegetables and fruits) the greater the need to replenish the organic matter either as farm manure or in some other form. Farm manure naturally varies in composition and should usually be supplemented with commercial fertilizer to maintain satisfactory balance of plantfood.

Phosphated manures — The use of superphosphate in stables is a practice which is generally recommended, in part because manure is low in phosphorus, as compared with its content of nitrogen and potassium. Also, superphosphate improves sanitation, reduces undesirable odours. It serves as an absorbent for the liquid portion of the manure and tends to prevent the loss of nitrogen in the form of ammonia. In the dairy barn use one-half pound of superphosphate spread in the gutter behind each animal each day after cleaning. In the horse stable, the application is best made just before cleaning the stable.

Paunch and poultry manures — Paunch manures are only partly-digested crude fibre and gastric juices and, being quite acid, should be used with caution, particularly for vegetable growing. When used, lime should be added to counteract the acidity, and nitrogen added to stimulate bacterial action in breaking down the crude fibre, otherwise nitrogen deficiency may result.

Poultry manure is much higher in nitrogen and phosphorus than ordinary farm manure and somewhat higher in potash (see Table 1, page 18). Where used, less supplementary fertilizer is needed.

Application rates for manure — In general farming light to medium applications of manure give greater returns *per ton* than heavy applications. Therefore frequent moderate applications of manure are to be preferred to infrequent heavy applications. Uniform distribution and thorough incorporation with the soil as soon as possible after spreading, insures the most effective utilization.

On the other hand, manure for fruit orchards, berry plantations, and vegetable crops should be applied in heavy amounts. Here the more intensive cultivation and cropping practices deplete the organic matter at an increased rate, requiring constant replenishing.

Also, if the supply of manure is limited, it is better practice to put more manure on a smaller area than to apply a small amount to a larger area. In fruit for instance, 10 tons of manure might better be applied to one-half acre rather than to spread this amount over one acre. The following year the remaining one-half acre could be manured. Vegetable and market-garden crops usually require heavier annual applications than fruit.

Soil Micro-Organisms

All living things supported by the soil return to it in the end, to be broken down by living microscopic organisms that swarm in the soil. In the process of getting food for themselves these micro-organisms break down the raw organic matter into the complex substance called humus, and this again into simpler elements. In turn, the micro-organisms themselves die, by uncounted billions, to add to soil organic matter.

Sugars, starches, and proteins are rapidly decomposed by micro-organisms; also cellulose and woody substances which take longer to break down. One of the products of decomposition by bacteria is ammonia, and from it nitrites and finally nitrates, a readily usable and very important plantfood, are produced. Bacteria also live on the roots of legumes from which they get food; and in return, they fix nitrogen from the air and build up the supply in the soil.

Other micro-organisms called fungi are numerous and active in the soil, especially under forest conditions. Some live in close association with the roots of plants in a mutually advantageous arrangement. Then there are protozoa, one-celled animals that feed on the bacteria, and slime molds which apparently feed on bacteria and fungi. Going up the scale of size, there are nematodes, worms, insects, and larger animals living in the soil and each having some affect upon it. Truly, —

The greater fleas have lesser fleas
Upon their backs to bite 'em,
And the lesser fleas have lesser fleas,
And so ad infinitum.

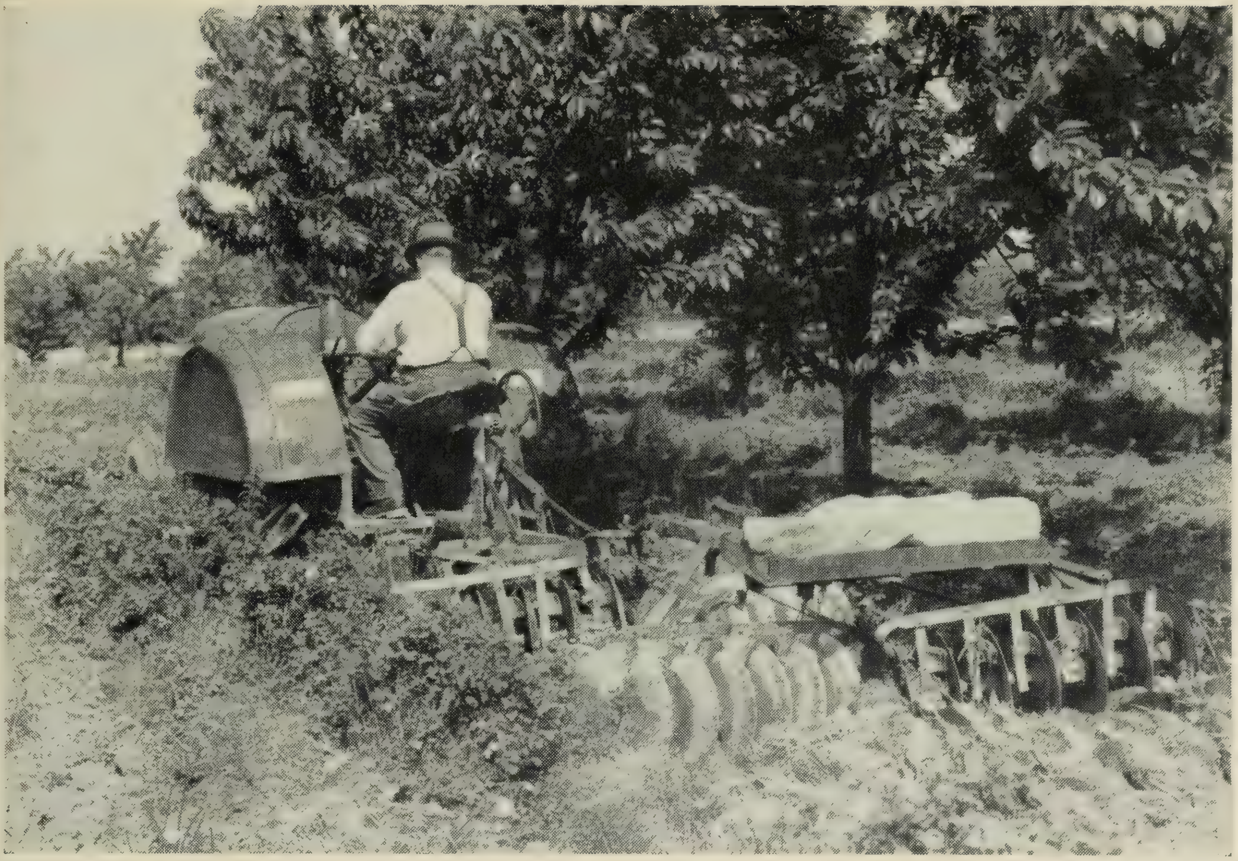


FIG. 4. Before plowing (if the nature of the crop to follow requires plowing) first trash disk to partly incorporate crop residues in the topsoil.

Trash Cultivation

Crop residues, green-manure crops, organic matter supplements as hay and straw, should first be lightly disked before plowing under. This trash disking partly incorporates the material in the topsoil and, when subsequently plowed under, there is no solid body or layer of raw organic matter to interfere with natural soil processes and plant growth.

Tillage

The purpose of cultivation is to prepare a seedbed, to lessen weed competition for moisture and plant nutrients, and to incorporate manures and other crop refuse. Cultivation speeds the decay of organic matter — a "stoking the furnace" process which should be recognized as such. The heavier the stoking to release plantfood and promote crop growth, the more "fuel" or organic matter must be added.

Frequent cultivation may so deplete organic matter that the soil's water-holding capacity is materially impaired. This is just as important for the cereal crops as it is for the more intensive fruit, vegetable, and hoed crops. It was once thought that cultivation conserved moisture. Actually cultivation conserves moisture only in-so-far as it removes competing weeds or cover crops. Therefore the cultivation of a weed- or plant-free soil does not conserve moisture in any appreciable degree. Nor does it promote the upward movement of water from the subsoil, or distribution sideways. Frequent and deep stirring of soil may in fact speed up water losses by exposing fresh amounts of moist soil. Also, the impairment of soil structure from unnecessary cultivation may be of more importance than moderate weed competition.

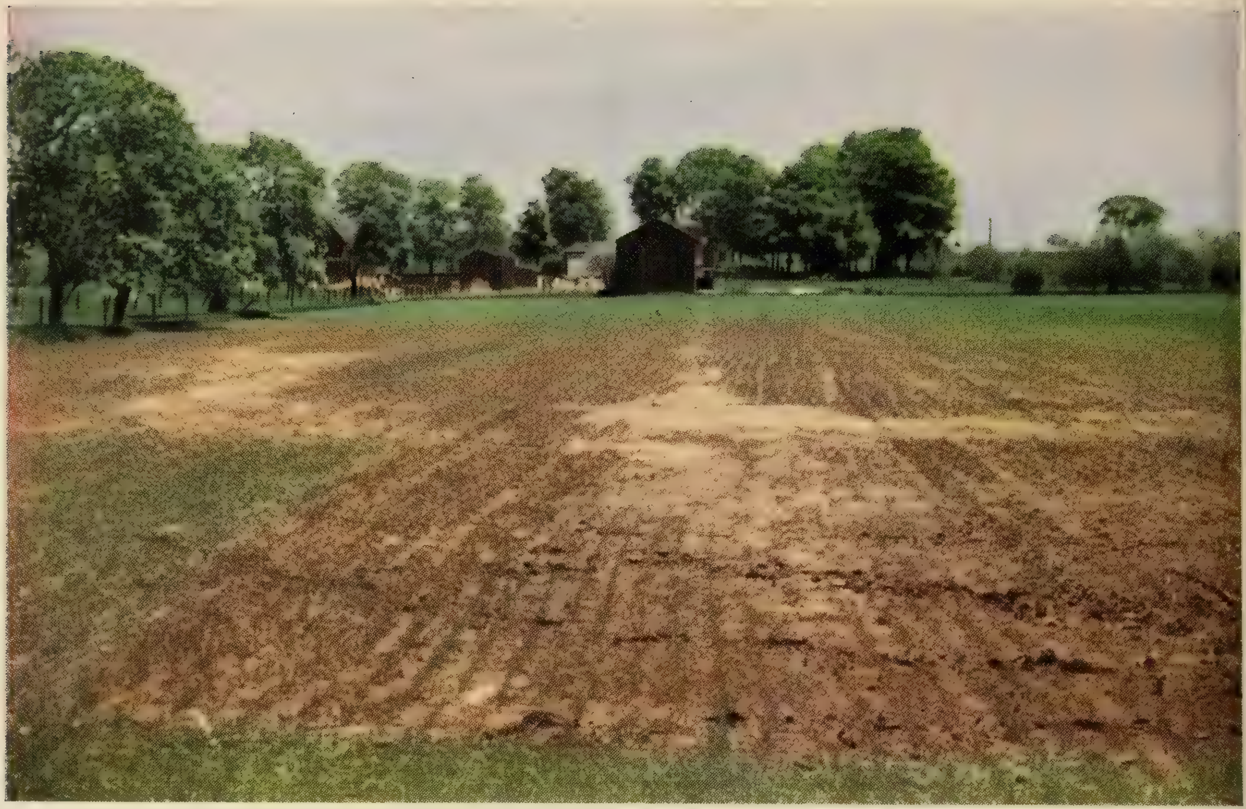


FIG. 5. There is sheet erosion even on gently sloping land. It is less spectacular than gully erosion, but results in a much greater loss of plantfood. Study the preventive measures outlined on page 16.

Reduce cultivation to a minimum for the soil type, the crop, and the conditions. If one or two cultivations serve the purpose then more are an unnecessary expense, and only increase the loss of organic matter, impair soil structure, and lower soil moisture.

Depth of cultivation is also of prime importance. The deeper the cultivation, the more active the destruction of organic matter, and the faster soil structure is destroyed. Also, injury to shallow-rooted crops may occur by the cutting of feeding roots near the surface.

In short, while tillage is essential for many crops, we must recognize that, the more soil is cultivated, the greater its loss of structure, the less fertile it becomes, the more tillage it requires to maintain production, and the less effective tillage becomes.

The Inherent Fertility of Soils

Most arable soils contain sufficient plantfood minerals to supply crop needs for many centuries. The productivity of a soil depends in large measure upon soil management practices directed towards making these minerals soluble, and thus available to the crop, and at the same time building a soil structure that will resist erosion and fixation. (See pages 15 and 16.)

The rate at which these minerals become soluble is largely dependent on the structure of the soil and the presence of ample organic matter, as it is under these conditions that the greatest activity of the soil micro-organisms, and the most rapid mineral breakdown, take place.

Under conditions of intensive cropping, the production of plantfood by the soil body itself may be profitably supplemented by the addition of commercial fertilizer.

Fertilizers have sometimes been used as a substitute for good soil management. The net result of this is the rapid degeneration of the structure of the soil, and the rapid depletion of organic matter, causing the plantfood producing processes within the soil body itself to slow down, thus making necessary larger applications of fertilizer.

The loss of soil structure also adversely affects the vigour of the root system with consequent deterioration in the vigour of the crop.

Thus it may be pointed out that the *substituting* of larger quantities of fertilizers *for good soil management* results ultimately in the soil requiring larger and larger quantities of fertilizer to produce poorer and poorer crops.

Fertilizers can be, and should be, a very profitable supplement to good soil management. The profit resulting from the use of fertilizer increases progressively as good soil management improves the structure and organic content of the soil.

Losses of Plantfood from the Soil

Even under the most improved practices of soil management inevitable losses of plantfood occur by fixation, leaching, erosion, and sale of crops, animals, and animal products.

Fixation — "Fixation" is the term used when part of the minerals applied to the soil in a soluble or available form are changed into insoluble or unavailable forms by chemical action within the soil. All soils have the ability to "fix" varying portions of the applied minerals, such as phosphate and potash. Factors favouring fixation are: wetting and drying; low organic content of soil; acid soils — pH 5.0 or lower; soils with high clay content; highly alkaline soils — above pH 7.5. (When soils are above pH 7.5, or below pH 5.0, 10% more fertilizers than ordinarily recommended should be applied, due to the certainty that fixation will be high.) Fixation can be reduced by plowing or disking-in of manure, crop refuse or residues, or green crops; use of lime on acid soils; drilling in rather than broadcasting of fertilizers; use of granular forms of fertilizers; deep placement of fertilizers.

Leaching — Losses of plant nutrients by leaching vary with differences in soil and soil management, and with changeable weather conditions. The most-leached soils are usually the well-drained coarse-textured soils, but since these soils are normally low in nutrients, there may be greater actual losses from the well-drained clay-loam soils. In a study of leaching losses from a good clay-loam soil in New York State, the following summarized results were obtained:

Average Loss of Nutrients by Leaching in Lbs. per Acre per Year

	Nitrogen	Phosphoric Acid	Potash	Lime (CaO + MgO)
Bare Soil	60 0	Trace	87	662
Rotation	7.8	Trace	69	395
Grass	2.5	Trace	74	447

Reference: The Nature and Properties of Soils — Lyon and Buckman.

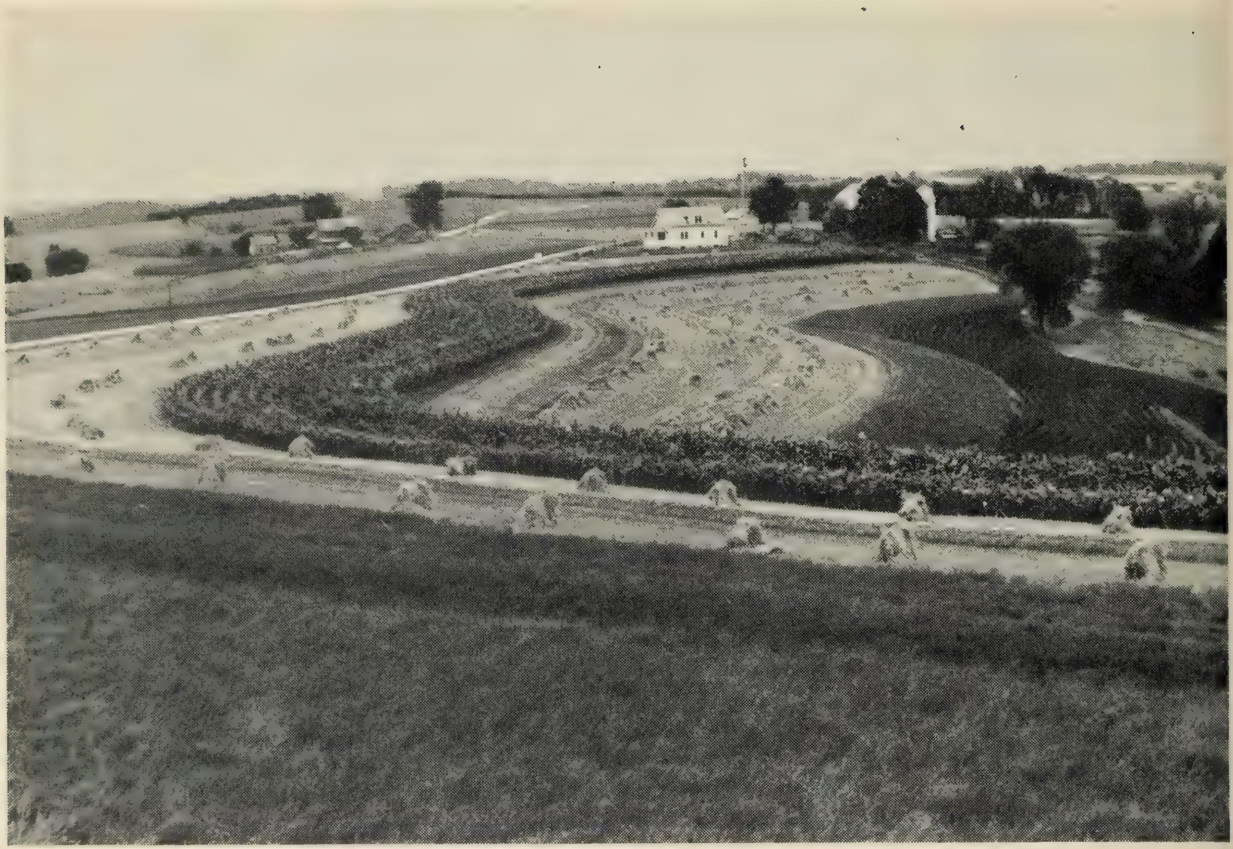


FIG. 6. Contour farming is an effective answer to sheet erosion. It protects the fertile topsoil.

Since organic matter acts as a storehouse of soil fertility, leaching losses can be diminished by maintaining a good supply of humus in the soil.

Erosion — The most fertile part of a soil is the topsoil, and this is the part which goes first in the process of erosion. In gully erosion, the coarse subsoil and underlying material is often spread out over good soils at the bottom of the slope and the finer silt and clay is carried away in the rivulet, creek and river, and finally deposited out in the lake. This type of erosion is the more spectacular, but a much greater total loss of plantfood results from sheet erosion. Whenever soils are bare and unprotected, the heavy dashing rains gnaw at the slopes, and the water which runs away over the surface carries with it some of the finer topsoil. The greater the speed of the water, the greater the amount of soil carried.

Preventive measures — (a) Leave the soil bare as little of the time as possible and still be in good keeping with good farm practice. (b) Maintain a good supply of humus by returning crop residues, manure, etc., and growing clovers, grasses and cover crops. This will help to keep the soil more porous and the rain will soak in. (c) Cultivate across the slope where practicable. (d) Leave sod strips between cultivated strips on sloping land. (e) Leave sod strips in the waterways. (f) Cultivate the more level land and leave the steeper slopes in permanent pasture or bush.

Removal by crops — In the same experiments referred to under "Leaching", the average annual removal of nutrients by the crops themselves in the standard rotation, and as compared with leaching, was as follows:

NUTRIENT REMOVAL IN CROP-ROTATED SOIL,
(A) BY THE CROP (B) BY LEACHING

	Nitrogen	Phosphoric Acid	Potash	Lime
(a) Crop Removal	60.0	25	50	50
(b) Leaching	7.8	Trace	69	395

It will be noted that, in these experiments, more nitrogen and phosphoric acid was removed from the soil by the crops than by leaching, but the reverse was true for lime. The difference was not great in the case of potash.

Where the soil is properly managed, Nature will supply a large proportion of the plantfood required for economic crop production. However, run-down soils, low-fertility soils, and even most of our so-called good soils, usually require additions of one or more nutrients in order to produce good yields of high-quality crops. The analyses of crops show that the proportionate amounts of nutrients taken from the soil vary widely with seasons, and with soils.

Let us look at the magnitude of these losses in terms of fertilizer replacements on an average farm. A good dairy cow will produce 8,000 pounds of milk in one year. Into that she will put phosphorus equivalent to that contained in 100 pounds of ordinary 20 percent superphosphate. With a herd of twenty such cows and the milk all sold off the farm, the annual loss of phosphorus from the farm, by this means, would be equivalent to one ton of 20 percent superphosphate.

Or if you prefer, let us consider the sale of livestock from the farm. One thousand pounds of livestock carries the average phosphorus equivalent of 80 pounds of 20 percent superphosphate. If the farmer sells 2 or 3 head of cattle, also calves, hogs, poultry and poultry products, these take with them fertility elements from the soil.

So does the sale of grain. For example, every 40 bushels of wheat, or every 50 bushels of barley sold from the farm, take from it the equivalent of 100 pounds of superphosphate. It is these continued losses of fertility, which if not compensated for, permit the depletion of the supplies of available phosphorus, calcium, magnesium, and other important minerals in the soil.

The following analyses of crops (Table 1) will give some idea of which crops are the heavy feeders on each of the main nutrients which are taken from the soil. (It should be noted that legumes have the ability to make use of nitrogen from the air.)

Lime

Lime adjusts soil reaction (see page 20); supplies calcium and magnesium as plant nutrients; aids in improving soil structure. Also nitrogen-fixing organisms function most effectively where the soil reaction is approximately neutral. More lime is required to change the acidity of a clay soil than a sandy soil, because the much larger colloidal-matter content (clay and humus particles) of the clay soil retards the neutralizing action of the lime.

TABLE 1. NUTRIENTS CONTAINED IN FARM CROPS AND PRODUCTS*

Crop	Yield	Part of Crop	Pounds		
			Nitrogen (N)	Phosphorus (P_2O_5)	Potash (K_2O)
Barley	50 bu.	grain	43.6	18.7	12.5
	2,500 lb.	straw	18.7	6.2	37.5
			62.3	24.9	50.0
Beans	25 bu.	seed	60.0	18.0	19.5
	2,000 lb.	straw	28.0	6.0	38.0
			88.0	24.0	57.5
Buckwheat	20 bu.	grain	15.0	6.0	3.0
	5,000 lb.	straw	62.5	7.5	57.5
			77.5	13.5	60.5
Corn	75 bu.	grain	71.2	28.7	18.7
	4,500 lb.	stover	47.5	15.0	68.7
	750 lb.	cobs	3.0	0.6	3.3
			121.7	44.3	90.7
Flax	15 bu.	grain	30.5	12.5	8.2
	1,800 lb.	straw	20.5	3.4	18.8
			51.0	15.9	27.0
Oats	75 bu.	grain	52.5	22.5	15.0
	3,750 lb.	straw	22.5	7.5	52.5
			75.0	30.0	67.5
Peas canning	1,800 lb.	grain	66.0	15.4	18.0
	4,500 lb.	straw	45.0	8.5	47.7
			111.0	23.9	65.7
Rye	30 bu.	grain	28.6	14.7	10.0
	3,000 lb.	straw	15.0	9.0	25.5
			43.6	23.7	35.5
Soybeans	25 bu.	grain	110.0	35.0	40.0
	2,500 lb.	straw	15.0	5.0	20.0
			125.0	40.0	60.0
Tobacco	1,500 lb.	leaves	55.0	10.0	80.0
	1,500 lb.	stalks	25.0	10.0	35.0
			80.0	20.0	115.0
Wheat	40 bu.	grain	46.6	21.3	12.0
	3,330 lb.	straw	20.0	5.3	28.0
			66.6	26.6	40.0
Mangels	20 ton	roots	60.0	40.0	140.0
Potatoes	300 bu.	tubers	65.0	25.0	115.0
		tops	60.0	10.0	55.0
			125.0	35.0	170.0

TABLE 1. NUTRIENTS CONTAINED IN FARM CROPS AND PRODUCTS* *(contin'd)*

Crop	Yield	Part of Crop		Pounds	
			Nitrogen (N)	Phosphorus (P_2O_5)	Potash (K_2O)
Sugar beets	15 ton	roots	55.0	22.0	53.0
		tops	60.0	23.0	92.0
			115.0	45.0	145.0
Turnips	10 ton	roots	50.0	20.0	90.0
Alfalfa hay	3 ton	all	140.0	30.0	135.0
Bluegrass hay	2 ton	all	53.0	21.6	84.0
Millet hay	3 ton	all	75.0	27.0	90.0
Red clover hay	2 ton	all	80.0	20.0	70.0
Soybean hay	2 ton	all	92.0	28.0	44.0
Sweet clover hay	5 ton	all	185.0	45.0	165.0
Timothy hay	1.5 ton	all	40.0	15.0	45.0
Apples	400 bu.	fruit	20.0	7.0	30.0
		leaves, wood	10.0	3.0	5.0
			30.0	10.0	35.0
Blackberries	4,000 qt.	fruit	11.0	3.0	12.0
Cherries	8,000 lb.	fruit	16.0	4.0	20.0
Grapes	4 ton	fruit	10.0	6.0	20.0
		leaves, canes	15.0	4.0	15.0
			25.0	10.0	35.0
Peaches	500 bu.	fruit	30.0	15.0	55.0
		leaves, wood	55.0	10.0	45.0
			85.0	25.0	100.0
Pears	300 bu.	fruit	7.5	3.0	15.0
Plums	200 bu.	fruit	15.3	5.5	21.3
Raspberries	4,000 qt.	fruit	10.5	4.5	12.0
Strawberries	6,000 qt.	fruit	13.5	10.3	27.0
Beets	12.5 ton	roots	62.5	25.0	125.0
Cabbage	15 ton	all	100.0	25.0	100.0
Carrots	10 ton	roots	46.0	26.0	106.0
Cauliflower	7.5 ton	heads	42.0	15.0	50.0
Celery	350 crates	tops	80.0	65.0	235.0
Cucumbers	100 bu.	fruits	5.5	3.3	11.0
Onions	500 bu.	bulbs	65.5	25.5	62.5
Parsnips	6 ton	roots	26.4	24.0	78.0
Tomatoes	10 ton	fruit	60.0	20.0	80.0
		vines	40.0	15.0	95.0
			100.0	35.0	175.0
Spinach	9 ton	all	90.0	30.0	45.0
Sweet corn	2 ton	ears	18.0	8.0	12.0
Cow manure	1 ton	86% moisture	9.7	2.8	9.5
Horse manure	1 ton	78% moisture	14.2	4.8	12.4
Poultry manure	1 ton	55% moisture	20.0	16.0	8.0
Sheep manure	1 ton	68% moisture	20.6	7.0	19.8
Swine manure	1 ton	87% moisture	7.6	6.8	8.4

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* Compiled, amended, and re-arranged from "Fundamentals of Soil Science by Millar and Turk", and, "When Fertilizing Consider Plant-food Content of Crops", by Romaine.

Most authorities agree that an addition of 1,000 to 2,000 pounds of ground limestone once in the 4-year rotation is sufficient to maintain optimum pH range in most agricultural soils. Not all soils need lime. In fact many Ontario soils have too much lime and the addition of more may be harmful. First have the soil tested, then use lime as required.

For best results lime should be fairly fine. Minimum standards of fineness recognized by the Ontario Department of Agriculture are:

100% should pass through a 10-mesh screen;
50% should pass through a 40-mesh screen;
30% should pass through a 100-mesh screen.

Dolomitic lime or lime containing magnesium is preferred for soil that is low in magnesium. Lime may be applied at any time during the spring, summer or fall. It is best broadcast and worked into the topsoil by harrowing or by disking and harrowing.

Soil Reaction — pH of Soils

The pH of a soil is the measurement of acidity or alkalinity developed in the soil solution. It has a definite bearing on the crops that grow in that soil. For example, rye will tolerate a soil with strong acid reaction, while alfalfa does best on a soil from near neutrality to slightly alkaline. The pH scale is divided into degrees, usually from 0 to 14, with each whole degree again divided into ten points. A pH of 7.0 is considered neutral, below this is the acid range and above this is the alkaline range. Lime is usually applied to adjust acid soils to a more favourable range.

TABLE 2. FAVOURABLE pH RANGES FOR SOME CROPS

FIELD CROPS		FRUIT CROPS	
Alfalfa	6.2 - 7.8	Apple	5.0 - 6.5
Barley	6.5 - 7.8	Blueberry	4.0 - 5.0
Clover	6.0 - 7.5	Cherry	6.0 - 7.0
Field Beans	6.0 - 7.5	Grape	5.5 - 7.0
Field Peas	6.0 - 7.5	Peach	6.0 - 7.5
Oats	5.0 - 7.5	Pear	6.0 - 7.5
Rye	5.0 - 7.0	Plum	6.0 - 8.0
Soybeans	6.0 - 7.0	Raspberry	5.0 - 7.0
Wheat	5.5 - 7.5	Strawberry	5.0 - 6.5
HOED CROPS		VEGETABLE CROPS	
Beans	6.0 - 7.5	Cabbage	6.0 - 7.5
Corn	6.0 - 7.5	Carrots	5.5 - 7.0
Mangels	6.0 - 7.0	Cauliflower	5.5 - 7.5
Potatoes	4.8 - 6.5	Celery	5.8 - 7.0
Pumpkin	5.5 - 7.5	Cucumbers	5.5 - 7.0
Sugar Beets	6.5 - 8.0	Lettuce	6.0 - 7.0
Tobacco	5.5 - 7.5	Onions	5.8 - 7.0
Tomatoes	5.5 - 7.5	Peas	6.0 - 7.5
Turnips	5.5 - 6.8	Table Beets	6.0 - 7.5

Nutrient Balance

Chief among the plant nutrients are nitrogen, phosphorus and potash, and, to a lesser extent only, calcium and magnesium. With all these, and the minor elements such as boron, manganese, copper, or zinc, available in sufficient amount, crop production should be at its best both as to quantity and quality. While each of these nutrients has specific functions in plant growth, it is becoming increasingly apparent that a *"balance"* between them is essential to optimum production. Serious nutritional difficulties, with accompanying marked plant symptoms, may arise where the "balance" of nutrients is wrong; that is, where there are deficiencies or excesses of this or that nutrient. These symptoms are not easily distinguishable one from the other. The book, Hunger Signs In Crops (see page 54) is helpful in diagnosing the particular nutrient which is in short supply. Pale foliage may indicate nitrogen starvation, marginal scorching of leaves suggests potash starvation, internal breakdown of turnips is symptomatic of a need for boron.

Also, to grow a healthy plant, *relative* amounts of nutrients are often of more importance than *actual* amounts. In other words it is the balance between plant nutrients which is of primary importance rather than their total amount (though a high level of *all* nutrients is essential to high, quality production). Thus in cases of a lack of nitrogen the plant cannot use phosphorus or potash effectively, even though they may be present in adequate amounts. Similarly, excess nitrogen may tend to emphasize potash deficiency symptoms which would not be present under *reduced* nitrogen conditions.

Whether or not a good relationship or balance of nutrients exists in a given soil depends on such factors as its original or virgin condition, its previous cultural treatment, and the fertilizer program being followed. Even starting with a well-balanced soil, its inherent fertility may be seriously impaired by faulty practices, such as over-cultivation with destruction of organic matter, and continuous use of single element or fixed-formula fertilizers. It is here that soil tests to determine nutrient levels have their value.

Soil Testing

Continued high production is contingent on good soil management, adequate fertility, and proper nutrient balance. The intensive cropping practices in use to-day make obsolete the haphazard methods of yesterday, so that no longer is it good management to apply fertilizer materials by guesswork. A handy tool in the hands of the farmer to-day is the knowledge a soil test gives in indicating nutrient balance and levels of plant-food. The more intensive the type of farming, the more important this information becomes. The time spent, therefore, in taking a proper soil sample is well repaid.

When to take a soil sample — Samples should be taken during the growing season from May to October, and sent to the laboratory as soon as possible after being prepared, so that they may be tested when time permits, thus avoiding peak loads in the laboratory work. Further, the soil is usually in much better physical condition for sampling during this period and samples more representative of normal nutrient levels can be obtained when the soil is in an active condition. Samples taken during the winter months are at their lowest level of fertility.

How to take a soil sample — In order that the sample may be quite representative of the land in question, it should be a *Composite* sample made up of soil taken from a number of places in the field or orchard to be sampled. In general farming 8 to 10 individual samples should be taken per field to form the representative sample, in orchard work at least 6 to 8 samples in each orchard, for market gardening 10 samples per acre.

Areas that represent different soil types, or have received different treatment, or that show differences in crop growth, SHOULD BE SAMPLED SEPARATELY.

At each of the places selected in the field or orchard, clear the surface of debris and, using a shovel or spade, make a hole to a depth of 6 to 8 inches, discarding the soil removed. From the straight side of these holes obtain a thin slice to the full depth of the hole and place it in a pail, basket, or other clean container. Mix the soil from the various places thoroughly and save ½ pint of it for analysis. This will be the *Surface* sample. Surface samples from a permanent sod should be taken from the upper four inches of soil.

Where a subsoil sample is desired continue the holes down for another 6 to 8 inches, then take a thin slice of soil from this second layer and place it in a separate container. Add other subsoil samples and take ½ pint of this for analysis. This will be the *Subsoil* sample.

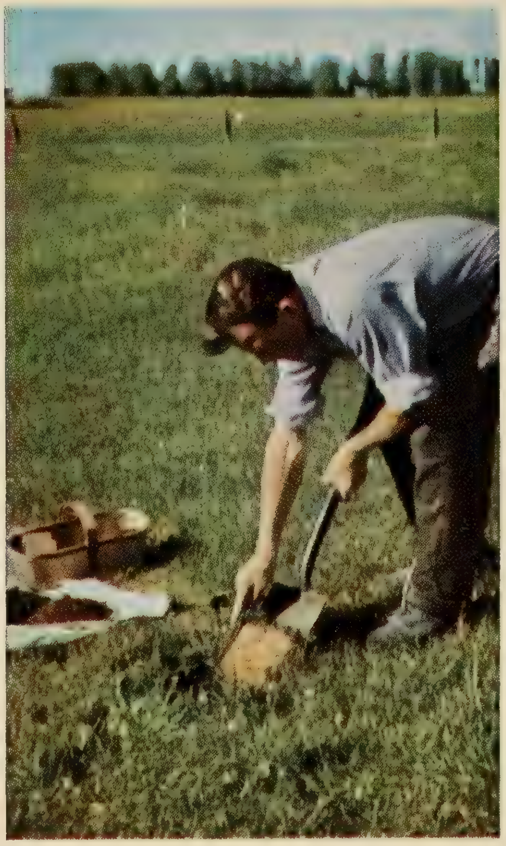

FIG. 7. A soil test is a useful and often-times necessary guide to soil fertility. Time and care in securing a proper soil sample will be well repaid in improved crop production.

The composite samples, both topsoil and subsoil, *Should be Spread Out To Dry* on clean paper in an open shed or other suitable place. *When Dry,* pulverize as finely as possible, place in strong paper bags, and label clearly. (Samples brought to the laboratory in a wet, or even moist condition, only delay the completion of the analysis, and frequently cause considerable congestion while drying, in the limited space of most laboratories.) Do not use match boxes, old tins or jars. Number your samples plainly and be sure to make, and keep for yourself, a plan of where you took the samples. Place your labelled samples in a strong carton and send them to the laboratory.

Soil Sampling Instructions and Question Blanks may be obtained from your Agricultural Representative, or from any of the test laboratories listed below. *Fill Out the Questionnaire as Fully as Possible.* It will help to make a better diagnosis of your requirements.

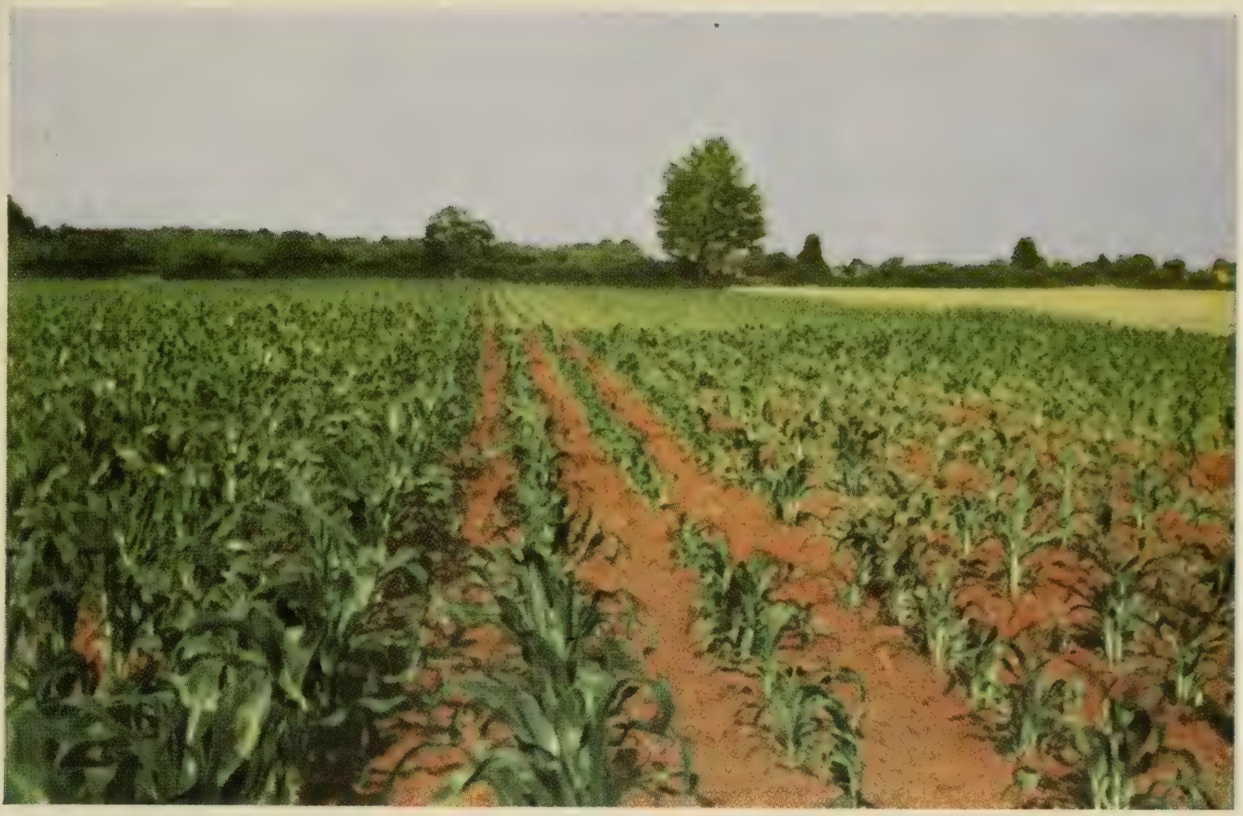

FIG. 8. Some crops (as corn) are heavy feeders and must be well fertilized to obtain high yields of good quality. Left, fertilized; right, not fertilized.

Where to send the samples — Samples which concern cereal grains, hay, pasture, corn, roots, potatoes, and vegetables (not market gardens), lawns, and home gardens, should be sent to the Department of Soils, Ontario Agricultural College, Guelph; the Western Ontario Experimental Farm, Ridgetown; or the Kemptville Agricultural School, Kemptville.

Samples which concern market gardens and greenhouses, should be sent to Department of Horticulture, Ontario Agricultural College, Guelph.

Samples which concern tobacco should be sent to Dominion Experimental Station, Harrow; or the Dominion Tobacco Sub-Station, Delhi.

Samples which concern tree fruits, bush fruits, and small fruits, should be sent to: In Eastern Ontario — Kemptville Agricultural School, Kemptville; in Central Ontario — Horticultural Experiment Station, Vineland Station; in Western Ontario — Dominion Experimental Station, Harrow.

FERTILIZERS

Origin and Use

The application of chemical substances to the soil, to supplement the native elements contained in it, has not been practised for a long time as agricultural history goes. But from the time Sir John Bennett Lawes, a hundred years ago, developed the technique of treating bones with sulphuric acid so as to render the phosphate contained therein into a form usable by plants, continuous progress has been made in our knowledge of plant nutrition and in the use of chemical fertilizers.

Canada consumes, currently, well over half a million tons of fertilizers annually, and the trend of usage steadily moves upward. The basic fact remains, however, that, valuable and even essential as fertilizers have proven themselves to be, they can only *supplement* and never *replace* good farm practices, as they are reflected in organic content of the soil, good tilth and proper aeration.

As has been pointed out (see page 17 and Table I, page 18) some losses of soil nutrients are inevitable, even under the best of farming practices. There are also certain soil types which, even in their original state, lacked essential elements required in the production of good crops. Thus the clay soils are, as a rule, lacking in available phosphates; and sandy soils are frequently deficient in nitrogen and potash. Therefore the use of chemical fertilizers in crop production is based upon the two facts as stated.

Soil tests are useful in indicating the amounts of N, P, or K required to maintain or to restore a balance of nutrient elements. In the case of badly-depleted soils the plowing-under of substantial amounts of superphosphate and muriate of potash and in some cases nitrogen, may be justified for this purpose, after which the more moderate quantities recommended for specific crops may be applied.

The need for fertilizers may be indicated in one or more ways. Reduced crop yields, poor quality of fruits or vegetables, low mineral content of roughages, may be symptoms of under-nourishment of crops. Actual symptoms of nutrient deficiencies may be detected on the foliage of the plant as noted under Nutrient Balance, page 20.

Higher Analysis Fertilizers

Research is continuously developing new and improved sources of plant food. For example, the development of ammonium nitrate and nitrogen solutions has made available nitrogen carriers which are twice as concentrated as the older and more familiar carriers such as nitrate of soda. Superphosphate now contains 19 to 20 percent phosphoric acid instead of the 14 to 16 percent of a few years ago, while manure salts, analysing 26 percent potash (K_2O) has been largely superseded by muriate of potash containing 60 percent K_2O.

It is therefore to be expected that as research develops these new and improved carriers of plantfood, the overall analyses of fertilizer mixtures will increase, and so far, this has been the rule.

Fifteen years ago the 2-8-4 was a popular fertilizer in Ontario, but it has now been completely discarded and replaced by fertilizer mixtures such as 2-12-6 and 2-12-10. In its day, the 2-8-4 was a good fertilizer. A ton of 2-8-4 fertilizer consisted, almost entirely, of those carriers which were necessary to supply the required amounts of plantfood. As more concentrated carriers of these plantfoods became available, it meant that fewer pounds of actual carrier material had to be used to supply the same amount of plantfood in each ton of mixture. The difference was made up with filler and, eventually, the content of the filler became so high that a 2-8-4 analysis had to be classified as inefficient and outmoded.

This trend towards higher analyses is still proceeding and certain analyses, such as the 2-12-6, the 0-14-7, and the 4-8-10, which are now popular, may also be expected to be replaced in the very near future by other fertilizer mixtures which are more efficient and more economical.

The fertilizer which is cheapest in dollars and cents per ton may not necessarily be the cheapest in actual content of plantfood or in actual fertilizing value.

Methods of Applying Fertilizers

There is no one method of applying fertilizers which will best suit all requirements of crops and soils. The underlying principle, however, is to place the fertilizer so that it will be available to the plant when it is most needed. Thus the "position" of the fertilizer may be just as important as kind and amount. Some of the better known methods are described herewith, and one of these, or a combination of one or more, should give satisfactory results.

Broadcasting or top-dressing without working into the soil — For such crops as hay and pastures this is the only practical method. A fertilizer drill, lime spreader, or cyclone spreader, may be used, or the fertilizers may be spread by hand on small areas or in orchards. Apply in fall or early spring when moisture is abundant, since, to be effective, these fertilizers must be dissolved and leached downward into the root area of the plant.

Broadcasting and plowing under — Under certain conditions it seems advantageous to plow under a portion of the fertilizers, as for instance:

(a) Potentially good land but seriously low in minerals. Moderate applications will not serve to replenish such soils to the point where high crop-yields can be expected. Therefore substantial amounts of mineral fertilizers may be broadcast and plowed down to be followed by a moderate application at planting time. Usually not more than two-thirds of the total fertilizers are plowed under, the remainder applied at planting time.

(b) Soils from which very high yields are expected and in which the nutrient levels may be medium to low. Thus, for potato yields of 600 to 700 bushels per acre, alfalfa yields of 4 to 5 tons, corn yields of 150 bushels per acre, high tomato yields, this plowed-down fertilizer has often given good results.

(c) In preparation for alfalfa or other forage crops intended to be left for a number of years. Deep application places the fertilizer in a desirable moisture and plant-root area.

(d) In fertilizing row-crops of high nutrient requirements, such as corn, tomatoes, potatoes, on soils of high phosphate or potash requirement.

Drilling or banding — An effective way of applying fertilizer is to place it in drills or bands to the side of, and slightly below, the plant or seed. Suitable machines adapted to the needs of farm and garden crops are on the market for these purposes.

Mixing fertilizers with the seed — Granular fertilizers may be mixed with the seed prior to sowing, provided that only moderate quantities are used. After mixing the fertilizer with the seed, it should be sown as soon as possible in order to avoid injury to germination.

Side-dressing — Row-crops are sometimes side-dressed during the growing season. The usual method is to apply the fertilizer approximately 4 to 6 inches from the growing plant and cultivate it into the soil. Nitrogen fertilizers are frequently used in this way, and also those containing both nitrogen and potash. Side-dressing may be done by hand but a fertilizer attachment to the single-row cultivator is recommended. Side-dressing

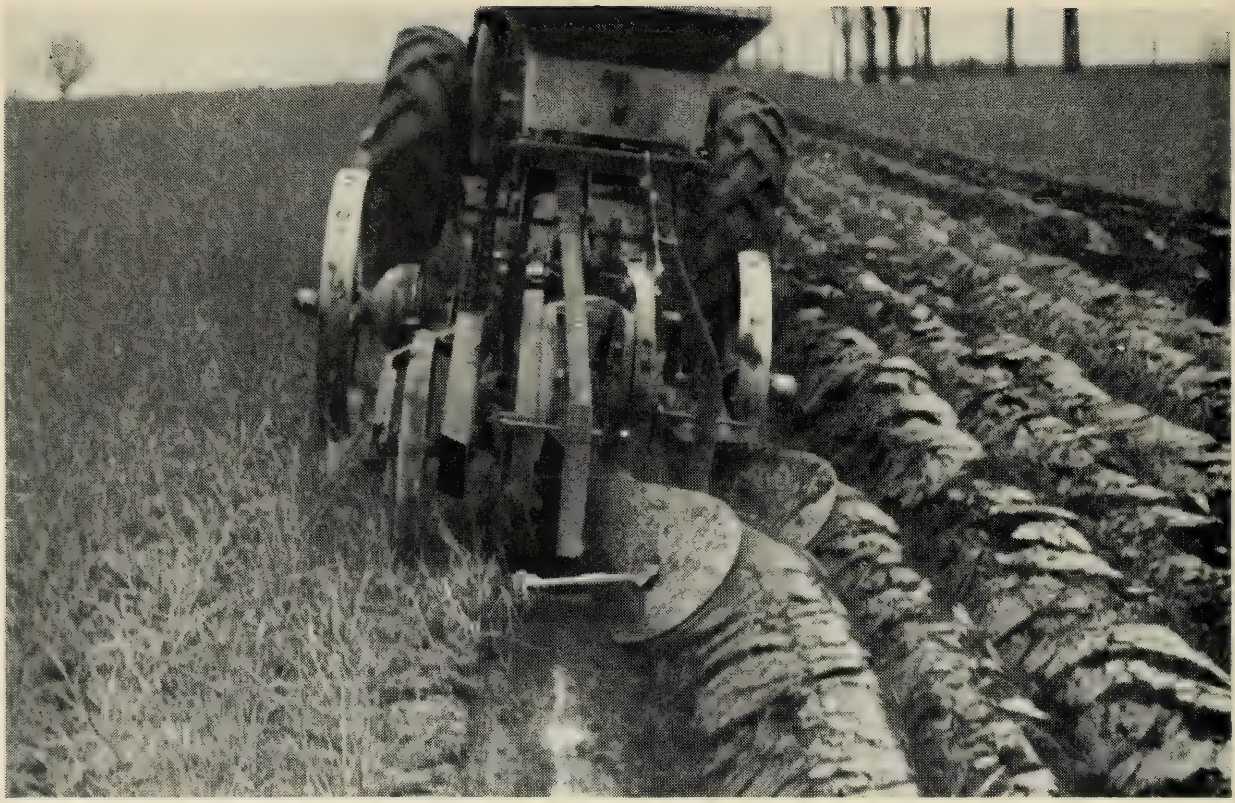

FIG. 9. Plow-sole application of fertilizers for general farm crops reduces the loss of plantfood by fixation.

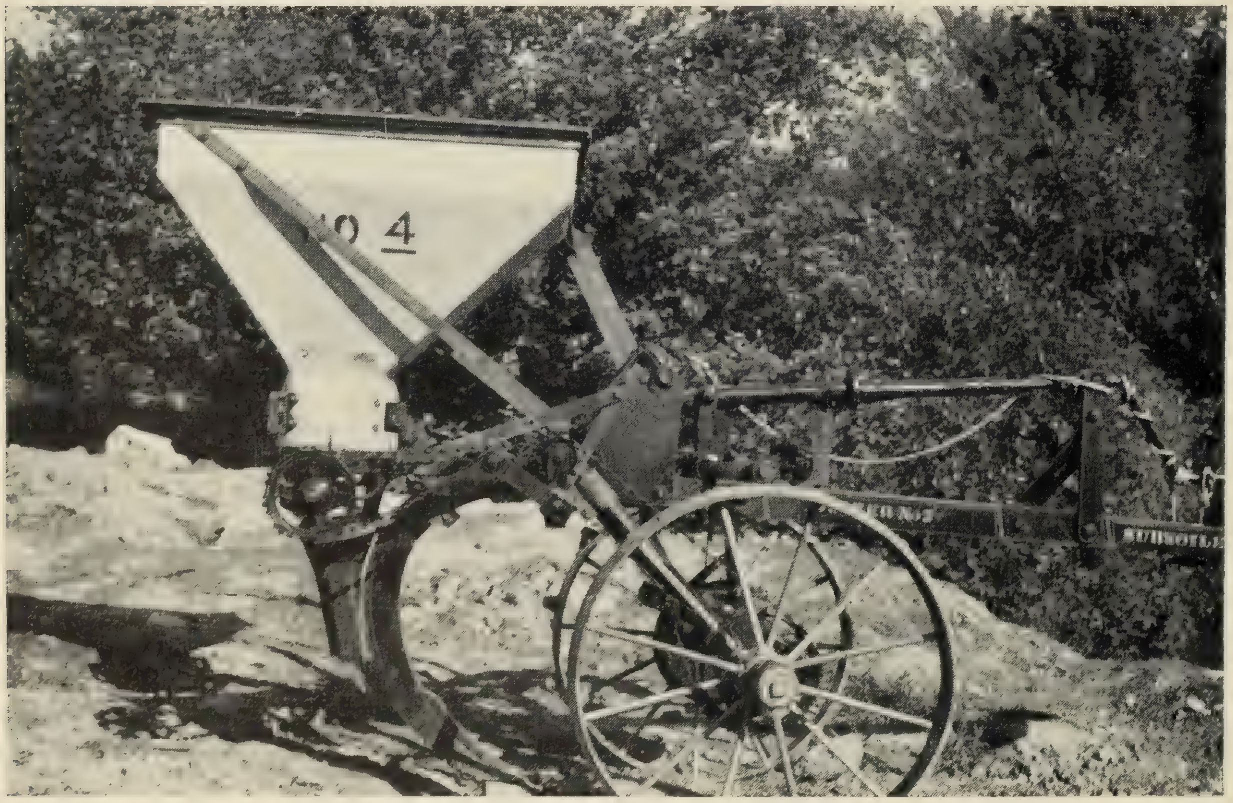

FIG. 10. In orchard work, deep placement of fertilizers is desirable and can be accomplished by a hopper attachment on a subsoiler. In addition, the subsoiler opens up compacted soils.

applications are dependent upon sufficient rainfall or irrigation to dissolve the fertilizer applied.

Phosphated manure — Where superphosphate is used in stables (see page 11), subsequent applications of superphosphate to crops may be reduced proportionately.

Fertilizers used in solution — Liquid fertilizer solutions may be used to increase the rate of growth of plants in flats, to overcome transplanting shock, and to re-start plants after a check by drouth or other factors. There are numerous commercial solutions and soluble powders on the market for this purpose. These should be used according to the manufacturer's directions.

A good home-mixed solution is made up as follows: 87 pounds ammonium phosphate, 57 pounds ammonium sulphate, and 44 pounds muriate of potash, dissolved in 40 gallons of water. For use dilute 1 gallon of this stock solution to 250 gallons of water. Apply this dilute solution at the rate of 1 cup per plant, or 1 pint per square foot of flat or bench space. If potassium and nitrogen only are required dissolve 8 pounds of potassium nitrate in 250 gallons of water and apply 1 cup per plant, or 1 pint per square foot of flat or bench space.

Some growers prefer to use 4-8-10 (or 5-10-13) dissolved in water. This fertilizer is not wholly soluble so the clear liquid is used and the sediment discarded. For a transplanting solution use 8 pounds of 4-8-10 or 6½ pounds of 5-10-13 in 40 gallons of water. For a booster solution use 16 pounds of 4-8-10 or 13 pounds of 5-10-13 in 40 gallons of water. For use apply 1 cup of the clear liquid per plant or 1 pint per square foot of flat, bench, or row. As a booster solution in the field for tomatoes, peppers and eggplants, dissolve 24 pounds of 4-8-10 or 20 pounds of 5-10-13 in 40 gallons of water, and apply 1 pint of the clear solution per plant several inches from the stem, six weeks after planting.

Fertilizers used when plowing under organic matter—When green-manure crops, corn stubble, or straw are plowed under (see page 13, Trash Cultivation), decomposition will be hastened by broadcasting some form of nitrogen prior to plowing. Cyanamid, ammonium nitrate, or sulphate of ammonia may be used, or a complete fertilizer high in nitrogen.

Fertilizing cover crops — Good farm practice requires that land should be under vegetation whenever possible. Vegetation reduces soil erosion and maintains or builds up organic matter with its many benefits. When the cover crops are well fertilized the resulting organic matter, being rich in minerals and nitrogen, is of additional benefit to the succeeding crop.

Deep placement in orchards — Under cultivated orchard conditions application of mineral fertilizers, particularly phosphate and potash, has not been too effective in overcoming deficiencies. Broadcast minerals do not move downward to the root zone to any great extent, and fixation is much greater where fertilizer is exposed to large soil surface-areas. A deep-placement machine overcomes these difficulties. This is an adaptation of a subsoil plow with mechanical means of sowing the fertilizer behind the chisel tooth of the subsoiler. For orchard work the machine runs at a depth of one foot and the fertilizer is placed at about nine inches from the surface.

Three precautions should be noted. Firstly, because this machine does some root pruning, deep placement should be made in the very late fall *only* and not at all in the spring. In the late fall the subsoil is usually dry and good "shattering" both of the subsoil and any hardpan present is accomplished. Secondly, only granular materials should be used as ordinary fertilizers will not readily flow through the machine. Lastly, deep placement should not be made closer to the trunks than just under the outer spread of the branches.

While no specific data can be presented to show the benefits of this method of fertilizing an orchard it is noted that rapid recovery of mineral deficiencies has been made, and that orchards so treated have improved in health and vigour.

In deep placement for truck crops and in general farming, there are attachments to fit an ordinary tractor-plow which place the fertilizer at the bottom of the furrow. In these crops the usual practice is to sow three-quarters of the required fertilizer by this method, and the remaining one-quarter by broadcast application.

Mixing Fertilizers at Home

In mixing fertilizers at home, the grower may determine what carriers of nitrogen, phosphorus and potassium, and their concentration, are to be used in compounding his mixture. On the other hand, he has little control of the chemical and physical reactions taking place after mixing and may find himself with sticky mixtures hard to sow. Also, in mixing small lots, errors in amount of each element may be made.

Compounding a fertilizer by use of the table — The left-hand column of Table 3 shows the percentage of nitrogen, phosphate and potash in the fertilizer material being used. The figures across the top of the table represent the percentage required in the mixture to be made.

For example: A 4-8-10 fertilizer compounded from 20% sulphate of ammonia, 20% superphosphate, and 60% muriate of potash is desired. Note the **bold-face** figures in Table 3. First find "20" in the left-hand column and move across the table along this line to the column headed "4%" and read "400". This indicates that 400 pounds of 20% sulphate of ammonia are required for 4% N. in the mixture. Similarly, on the "20" line will be found 800 pounds for 8% phosphate in the mixture; and finally, on the "60" line will be found 330 pounds for 10% potash in the mixture.

The resulting 4-8-10 mixture is shown in the following summation. As a comparison, and to show how a higher analysis mixture cuts the amount of filler per ton of fertilizer, the formula for a 5-10-13 analysis is also shown. This 5-10-13 gives the same ratio of plantfoods as the 4-8-10, but is more concentrated, has practically no filler. Eventually, (see page 24, Higher Analysis Fertilizers), the higher concentrations will replace present widely-used mixtures as 0-14-7, 2-12-6, and the 4-8-10 noted above.

4-8-10		5-10-13
400 lb.	20% Sulphate of Ammonia	500 lb.
800 lb.	20% Superphosphate	1,000 lb.
330 lb.	60% Muriate of Potash	429 lb.
470 lb.	Filler	71 lb.
2,000 lb.		2,000 lb.

Several nitrogen carriers may be included in the same mixture. For example, rather than have all the nitrogen (4%) in the above mixture from sulphate of ammonia, one may use 2% from sulphate of ammonia, 1% from ammonium nitrate and 1% from cyanamid. In this case use the table as before for each of the carriers at the percentage required.

How to mix — Proper mixing of the ingredients is essential to making a uniform product. A cement mixer may be used, or if mixed by hand start with one-half the superphosphate in the bottom layer and follow with succeeding layers of the remaining materials. Finally, over the top of the pile, spread the limestone filler. Then mix thoroughly by turning the pile several times.

Do not fill the bags full but allow four to five inches between the top of the fertilizer and the tie. After bagging, careful storage is necessary to keep the fertilizer in good condition until used. Place boards beneath the piled bags to keep the fertilizer from drawing moisture from the floor, and keep the pile a few inches from any wall.

TABLE 3. COMPUTING HOME-MIXED FERTILIZERS

Percent of N. or P_2O_5 or K_2O in Fertilizer Material	**Percent Desired in the Mixed Fertilizer**										
	1%	**2%**	**4%**	**5%**	**8%**	**10%**	**12%**	**13%**	**15%**	**16%**	**20%**
3	667	1334									
11	182	364	728	910	1456	1820					
16	125	250	500	625	1000	1250	1500	1625	1875	2000	
18	111	222	444	555	888	1110	1332	1443	1665	1776	
20*	100	200	**400***	500	**800***	1000	1200	1300	1500	1600	2000
21	95	190	380	475	760	950	1140	1235	1425	1520	1900
22	91	182	364	455	728	910	1092	1183	1365	1456	1820
33	61	122	244	305	488	610	732	793	915	976	1220
42	48	96	192	240	384	480	576	624	720	768	960
45	44	88	176	220	352	444	528	572	660	704	880
48	42	84	168	210	336	420	504	546	630	672	840
50	40	80	160	200	320	400	480	520	600	640	800
60*	33	66	132	165	264	**330***	396	429	495	528	660

* See page 28 for detail of a 4-8-10 mixture compounded from 20% sulphate of ammonia, 20% superphosphate, and 60% muriate of potash.

> *"The Earth is the Mother of us all — plants, animals, and men . . . Nature treats the earth kindly. Man treats her harshly. He overplows the cropland, overgrazes the pastureland, and overcuts the timberland. He destroys millions of acres completely . . . The flood problem insofar as it is man-made is chiefly the result of (this) overplowing, overgrazing, and overcutting of timber . . . The social lesson of soil waste is that no man has the right to destroy soil even if he owns it in fee simple. The soil requires a duty of man which we have been slow to recognize."*
>
> From Soils and Men, U.S.D.A. Yearbook of Agriculture, 1938.

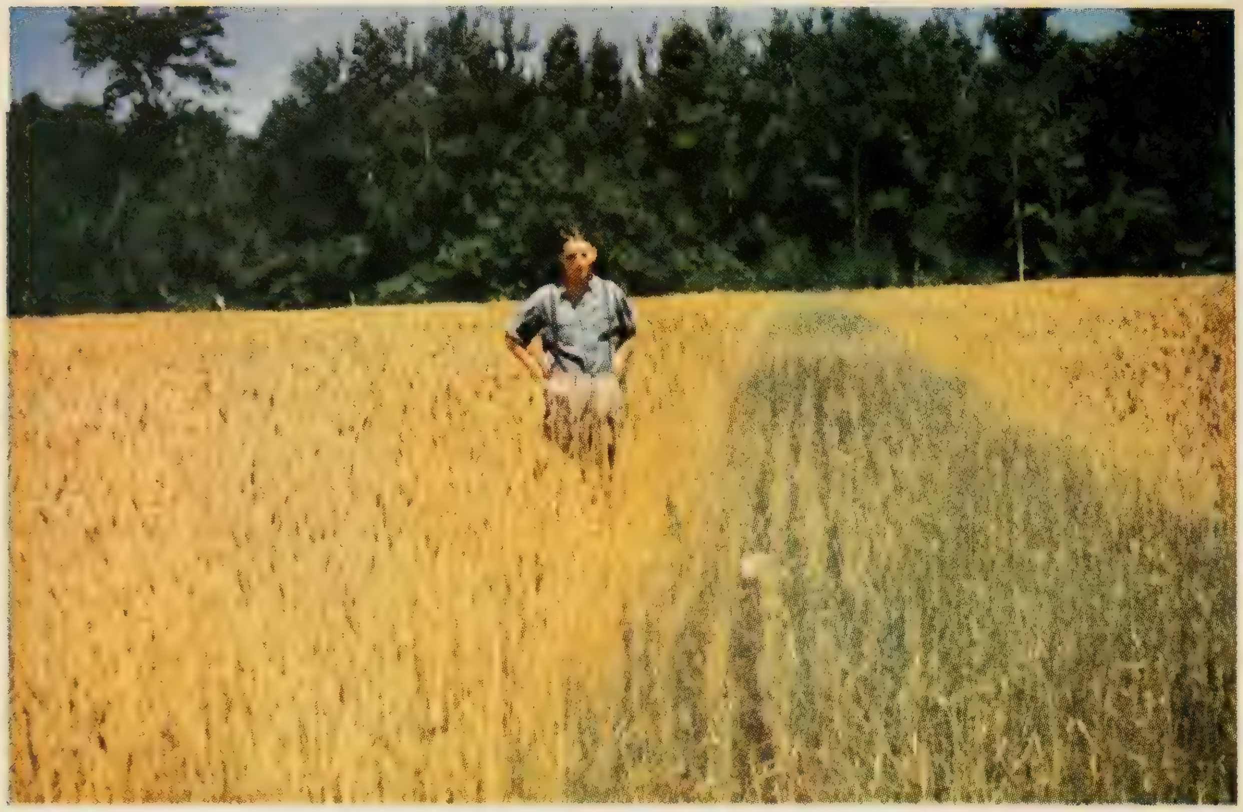

FIG. 11. Fertilizers supplement good farm practice. They do not replace it. The need for fertilizers may be indicated in various ways such as the reduced yield in the unfertilized grain plot above (right).

RECOMMENDATIONS FOR SPECIFIC CROPS

Cereal Crops

General considerations — The influence of fertilizers on the catch of clovers and grasses seeded with the cereal crops, and the residual effect on succeeding crops, may be as important as the effects on the immediate cereal crop itself. Also, proper use of fertilizer offers substantial insurance against winter killing of fall-sown grains and hay crops.

Fertilizers for cereal crops except peas (see page 31, Field Peas) should be applied in the drill row with a combination fertilizer drill, or with a fertilizer attachment on the drill, rather than by broadcast application.

While the specific fertility needs of the soil may be more accurately determined by chemical soil tests (see page 21, Soil Testing), the following general fertilizer mixtures and rates are suggested as guides.

Fall-sown grains — wheat, barley, rye — Use 2-12-10 or 2-16-6 at 300 pounds, or 3-18-9 at 200 pounds per acre. If previous crops have shown a tendency to lodge, it is an indication of an unbalanced food supply, and 0-16-8 or 0-12-12 at 300 pounds per acre is recommended. Where an adequate amount of farm manure is used in the crop rotation an application of 20% superphosphate at 200 pounds per acre may be sufficient.

If it is the intention to seed down the fall-sown crop with a grass mixture the fertilizer should be applied at 300 to 400 pounds per acre. If legumes are to be seeded the following spring the fertilizer should be applied at the rate of 400 to 500 pounds per acre at the time of seeding the fall grain.

Spring-sown grains — wheat, oats, barley, buckwheat — Not seeded down — When seeding the spring grain crop alone, use 2-12-10 or 2-16-6 at 250 pounds, or 3-18-9 at 200 pounds per acre. Where the supply of manure in the rotation is limited, 4-12-6 at 300 to 350 pounds per acre is recommended. If lodging has occurred in previous cereal crops use 0-16-8 or 0-12-12 at 200 to 250 pounds per acre, or where the supply of potash is adequate use 20% superphosphate at 150 to 200 pounds per acre.

Spring-sown grains — seeded down — When spring grains are to be used as a nurse crop use 2-12-10 or 2-16-6 at 300 to 350 pounds, or 3-18-9 at 200 to 250 pounds per acre. Clover and alfalfa are generally not very responsive to nitrogen applications and where an abundant supply of this element is present use 0-16-8 or 0-12-12 at 300 to 350 pounds per acre. Clovers and alfalfa are heavy users of potash, and where this element is known to be deficient use 0-12-20 at 300 pounds per acre.

Field peas — For field peas apply either 0-12-12 or 2-12-10 at 300 pounds per acre. Since the germination of peas is affected by close contact with fertilizer, it is preferable that the fertilizer should be drilled-in previous to sowing the crop, and at a slightly greater depth than the seed.

Inter-tilled Crops

Field beans — Field beans grow well following clover sod which has been manured. This treatment may be supplemented to advantage with moderate applications of 2-12-10, 2-16-6, or 3-18-9, drilled-in with a combined fertilizer and grain drill. Special care should be taken to avoid contact between the seed and fertilizer in planting as bean seedlings are easily damaged by direct contact with fertilizer, especially if the weather is dry after planting.

Soybeans — Soybeans are heavy users of calcium, phosphorus and potash. On well-limed soils seed inoculation is more effective, and nitrogen fixation from atmospheric sources is more efficient. Inoculation each time the crop is planted has given profitable returns. The availability of lime can be the limiting factor in success of inoculation.

On soils known to be medium to low in potash, apply 125 to 250 pounds per acre of 0-12-12, and on lighter soils 2-12-10. Good results are obtained by plowing down three-quarters of the total fertilizer application, using the remainder as a side-dressing at planting time. Avoid contact between the seed and fertilizer.

Field corn — While good results are usual from the use of phosphated manure, the corn crop is also a fairly heavy user of potash and it ordinarily pays to use a mixed fertilizer fairly high in both phosphate and potash. Where manure is used, or a clover sod is plowed down, 0-16-8 or 0-12-12 are suitable. Where no manure is available or where there is no clover sod to plow down, use fertilizers containing nitrogen, such as 2-12-10 at 300 to 400 pounds per acre.

When both corn and fertilizers are sown with a combined grain and fertilizer drill, most growers prefer to apply the fertilizer only through the tubes that are not seeding corn. When a corn planter is used, the fertilizer should be sown on each side of the seed-shoe rather than in the

FIG. 12. **The potato is a heavy feeder. Profitable yields are the combined product of organic matter, plantfood, and moisture, all in adequate supply.**

tube with the seed. Fairly heavy applications of fertilizer applied with the seed tend to burn the seedlings, especially in dry weather.

After harvesting the ears of husking corn, the stalks may be plowed down. Before plowing apply 75 to 100 pounds of ammonium nitrate, or equivalent, to speed decomposition. This soil treatment will favourably influence the next crop in the rotation.

Potatoes — The growing potato plant uses large amounts of both water and plantfood. The absorption of plantfood is dependent on a sufficient supply of moisture. The water-holding capacity of any soil is dependent on the presence of adequate organic matter. Thus profitable yields are the combined product of organic matter, plantfood, and moisture.

The grower cannot regulate rainfall, but he can influence the quantity and quality of organic matter and plantfood available for the growing crop. Organic matter can be maintained at a satisfactory level by the addition of farm manure and the use of short rotations including the plowing down of such crops as legumes and winter rye. A recommended practice is to have the potato crop follow the legume crop in the rotation. The second growth of the legume is allowed to develop after the removal of the hay. Apply about ten tons of farm manure per acre, then plow and work up in sufficient time to seed to winter rye at the rate of 2 to 3 bushels per acre. An application of 300 pounds per acre of 2-12-10 at the time of seeding the rye ensures a thicker growth of rye and benefits the succeeding potato crop.

The rye crop should be plowed down the following spring when it reaches 12 inches in height and at least two weeks before planting time. Trash disk, then plow under sufficiently deep to cover the rye thoroughly.

Fertilizer application at planting time — On sandy or loam soils, use 4-8-10 at 1000 to 1500 pounds, or 5-10-13 at 800 to 1200 pounds per acre. On heavier soils, use 2-12-10 at 1000 to 1500 pounds per acre.

The preferred method of applying fertilizers is by using a potato planter with fertilizer attachment. Alternative methods are: (a) drilling on the rye crop before plowing down; (b) placing in the bottom of a plow furrow by means of a plow attachment; (c) drilling the fertilizer deeply into the seedbed. This latter method of application has been found to be the least satisfactory.

Sugar beets — A rotation which includes legume crops is essential. Increased yields are obtained when beets follow legumes and where liberal quantities of manure have been applied. Although fertilizers do not take the place of organic matter obtained from clover and manure, their use generally gives increased yields. Fertilizers high in phosphate are usually found to give increased returns, but the fertilizer analysis used should be based upon soil tests. A 2-16-6 has proven very satisfactory for soils low in phosphate, and 2-12-10 is recommended for lighter soils where potash is low. Superphosphate gives excellent results on marl soils and other soils high in organic matter and well supplied with potash. Use 0-12-20 on low potash, high organic-matter soils.

Applications are most effective in the row. They should not exceed 250 pounds per acre when the fertilizer is applied in contact with the seed. New types of beet drills separate the seed and fertilizer. The ideal placement of fertilizer is about ½ inch to the side and 1½ to 2 inches deep. Unless the seed and fertilizer are separated, additional applications of fertilizer should be made with a grain drill, a broadcasting device, or applied as a side-dressing at the time of early cultivation. An application of 300 to 400 pounds per acre usually gives economical returns when applied as suggested above.

Borax — Apply 20 pounds per acre on soils where heart rot has appeared previously. If borax is mixed in the fertilizer and is applied in contact with the seed, do not use over 5 pounds of borax per 100 pounds of fertilizer because of possible seed germination injury.

Fungicidal fertilizer — Good results in the control of black root, a disease of the root at early-growth stage, have been obtained by treating the fertilizer with 1 percent Arasan. This fungicidal fertilizer must be applied with the seed. High temperatures offset its fungicidal value so its use after June 15th will not give control.

Mangels — The mangel is a heavy feeder, resembling the sugar beet in its fertilizer requirements. Under average conditions apply 12 to 15 tons of manure per acre, plus 375 to 500 pounds 2-12-10.

Turnips (Rutabaga) — Under average conditions apply 10 to 12 tons of farm manure and 375 to 500 pounds per acre of 0-16-8, or 2-12-10, as indicated by soil test. Where phosphate is deficient use 2-16-6 at the same rate.

Where water core or brown heart of turnips has occurred previously it is good protection to spray the turnips with a solution of borax to which a spreader and sticker have been added. A dust containing similar ingredients may also be used.

FIG. 13. When properly managed and fertilized, hay is one of the most economical sources of feed. The mineral content of hay is definitely higher from rich soils than from poor soils.

FIG. 14. Kale and rape make good emergency or supplementary fall pasture. They require high-nitrogen fertilizers.

In certain localities, mostly in areas of slightly acid soils, good results have been obtained by adding sufficient granulated borax to the regular fertilizer to give a borax application of 15 to 20 pounds per acre.

For particulars on mixing and applying borax to turnips see Extension Circular 68, Guide to Crop Production in Ontario.

Hay and Pasture Crops

General Considerations — Hay and pasture crops provide the most economical sources of feed for the production of milk and beef. Consequently they are the foundation of our dairy and livestock industry. Care and effort in their management will be amply repaid. Especially is this so under conditions which call for maximum production of livestock and dairy products. Good pasture maintains livestock for four to six months at low labour and feed costs. It produces meat and milk fifty to seventy-five percent cheaper than by winter feeding. It is rich in digestible protein and high in vitamins.

Good pasture prevents soil erosion and builds up organic matter, thus increasing the moisture-holding capacity of the soil.

Improved grass and legume mixtures, on soil where adequate fertility levels are maintained, and under good livestock management practices, can produce from 5000 to 6000 pounds of milk per acre, or carry 1½ cows per acre during the season. It should also produce 200 to 300 pounds increase in live weight of beef animals during the season. Improved strains of grasses and clovers in suitable mixtures, cut early and properly cured, are capable of producing hay sufficiently high in nutritive value that the grain portion of the winter ration for both dairy and beef cattle may be reduced as much as twenty-five percent.

Best response from fertilizers will be obtained when they are applied to a productive soil carrying a good stand of grasses and legumes. Do not over-graze or under-graze pastures. Over-grazing reduces the yield and increases injury from drought and frosts. Some grasses and legumes are easily killed by close grazing, or so weakened that excessive drought or cold kills them, and allows weeds to enter. Pastures should go into winter with a good strong top, four to six inches, in order to obtain a strong start the following spring.

Weeds in pastures are best controlled by encouraging a thick sod by top-dressing with fertilizers or manures, and by good grazing management. Mowing tall weeds in the early blossom stage prevents re-seeding, and assists in the formation of a good turf and the production of more nutritious pasturage. It is usually cheaper to plow, fertilize and re-seed thin, weedy pastures on good plowable soil than to attempt their improvement by the application of fertilizers and manures.

To promote uniform grazing, droppings should be spread by harrowing whenever necessary. Some farmers find that harrowing in July and October serves the purpose satisfactorily.

Hay and pasture grown on rich soils well supplied with plant nutrients have been found to be definitely higher in mineral content than similar crops grown on poor soils.

The use of the electric fence in rotational management of pastures is inexpensive, and effective in permitting better utilization of the feed produced.

Seeding long- and short-term hay and pasture areas — If a good seeding is established, the production of hay and pasture from the area is usually assured for the next three to four years of the rotation, providing good management is followed. Consequently, the cost of cultivation, seed, and fertilizer is chargeable not only to the initial but to the succeeding crop as well. No reasonable effort, therefore, should be spared to insure success by careful soil preparation, good seed, and adequate fertilization.

The failure of many seedings in Ontario is due to low organic-matter content, lack of sufficient food in the soil to establish the young plants, and poor seeding methods. The necessary plant nutrients, nitrogen, phosphate, potash, and calcium, must be available in adequate amounts. If soil tests indicate that any of these are lacking, sufficient fertilizer should be added to make good the deficiency. For the most part, the fertilizer should be incorporated deeply enough to be available to the young plants.

Fertilizing to maintain production — Table 4 indicates the fertilizer mixtures and quantities recommended for average conditions. Soil tests may indicate the desirability of using a different mixture or amount.

Where quick results are required it is frequently desirable to top-dress with some form of nitrogenous fertilizer. To supply the necessary nitrogen apply 125 pounds of cyanamid or ammonium sulphate, or 75 pounds of ammonium nitrate per acre. This is a minimum recommendation. These materials are best applied broadcast in the early spring after growth has started.

TABLE 4. FERTILIZERS FOR HAY AND PASTURE

	Light Soils		**Heavy Soils**	
	Analysis	**Amount**	**Analysis**	**Amount**
Short-term Hay and Pasture, Long-Term Pasture				
Mostly Grasses	4-12-10	250-350	4-12-6	250-350
Mostly Legumes	0-12-12	250-350	0-16-8 or 0-20-0	250-350 250-350
Mixtures	2-12-10	250-350	3-18-9	250-350
Natural Grass Pastures	4-12-10	250-350	4-12-6	250-350
Supplementary Pasture Crops	4-12-10	250-350	4-12-6	250-350

Farm manure — One of the most profitable places to apply farm manure is on the hay and pasture areas. Six to ten loads (9 to 15 tons) per acre should be sufficient for a single application. Frequent light dressings are preferred to heavy, infrequent treatments. The practice of adding phosphate to manure in stables increases the effectiveness of the manure and is a satisfactory method of applying phosphorus. (See page 11, Phosphated Manure.)

Time and method of application — Experiments show that fall applications (September 15 to October 15) of both manure and mixed fertilizers give more profitable results than spring treatments. The next best time is in early spring. The top-dressing of fields with manure during the winter months is satisfactory on level land. On rolling land it is better to pile the manure and spread it in early spring.

Supplementary pasture crops — During dry weather in July and August in Ontario there is generally a need for grazing on dairy farms which can be met by annual pasture crops such as oats, sweet clover, millet, Sudan grass, rye, rape, or kale. As these crops are to be harvested in the leafy stage by the cattle, the use of a fertilizer high in nitrogen is recommended.

Fruits

First read Soil Sense, pages 7 to 23, for a better understanding of soil management and fertilizer use. Note particularly the items, Aeration and Drainage, Organic Matter, Manures, Tillage, and Nutrient Balance. Also consult Bulletin 457, Orchard Soil Management.

Fertilizer recommendations for orchard, vineyard, and small-fruit plantations, as briefly set forth in the accompanying chart, must be regarded as supplementary to a soil management program which desirably influences soil structure, and therefore the inherent fertility and durability of the soil.

Tree Fruits

Nitrogen — In orchard work, time and method of application practically require that the nitrogen be applied separately from the minerals — phosphate and potash. No definite nitrogen recommendations have been included (except for hay and straw). Whether or not nitrogen should be applied to tree fruits, and in what quantity, will depend primarily on the age and condition of the trees, whether cultivated or sod, the nature of the sod (legume or non-legume), and the present mineral content of the soil. Nitrogen applications to a low mineral-content soil are likely to be harmful rather than beneficial. Nevertheless most *bearing orchards* require nitrogen. Apply as needed and in the form preferred by the grower. On alkaline soils, a nitrogen fertilizer with an acid reaction, such as ammonium sulphate, has some advantage.

To best accomplish its purpose, nitrogen should be applied in the late fall or well in advance of tree growth in the spring, and generally before the soil is fit for cultivation. Such applications, however, are soon available to the trees and without appreciable loss of the fertilizer applied.

Fall and spring applications — The various forms of nitrogen, nitrate of soda, ammonium nitrate, ammonium sulphate, and cyanamid, are about equally effective if applied at the proper time. Ammonium sulphate and cyanamid can be used to advantage in the late fall, but nitrate of soda and ammonium nitrate should be used as early spring applications, and as required during the growing season. Spring applications, particularly of cyanamid, should be made three weeks before growth starts. Recent experience indicates that cyanamid should not be applied to sweet and sour cherries at any time. For peaches and plums it is best applied in the late fall.

In eastern Ontario, for apple orchards, spring application of all forms of nitrogen is generally preferred, as fall applications, unless carefully timed, may predispose the trees to winter injury. This applies to both sod and cultivated orchards.

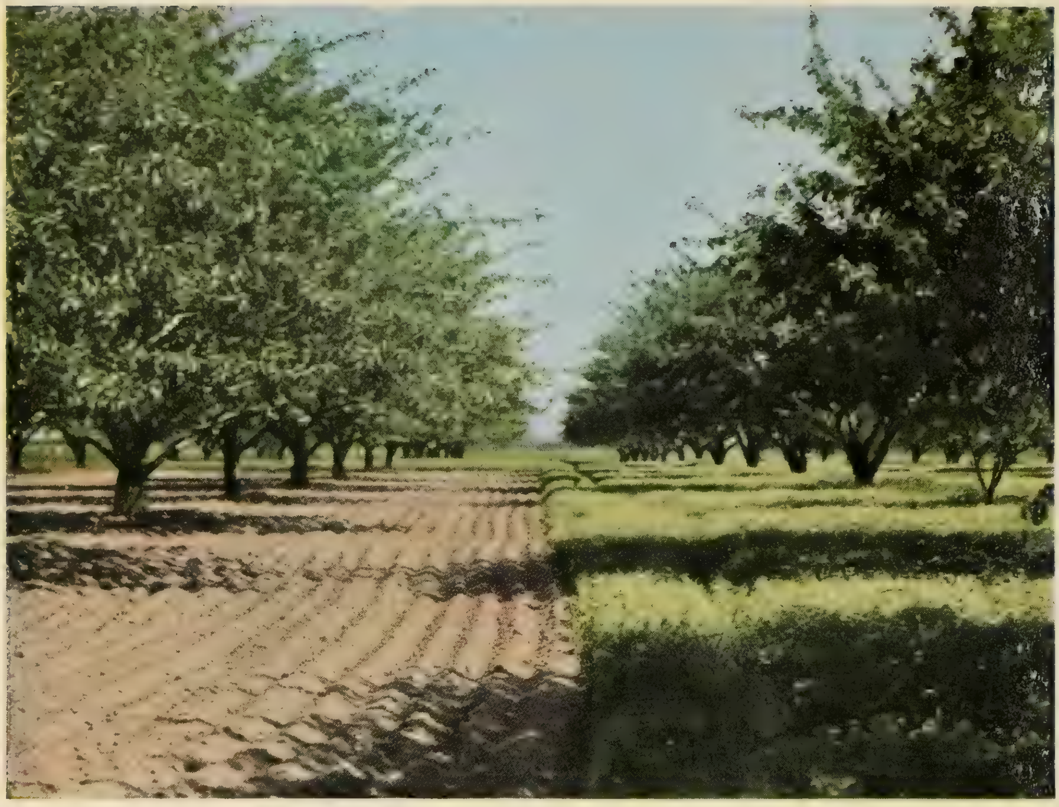

FIG. 15. Conserve organic matter in orchard soils by reducing the time and amount of cultivation, and seeding early to green-manure crops.

Moderate nitrogen applications — Ammonium sulphate 1/5 lb., *or* cyanamid 1/5 lb., *or* ammonium nitrate 1/8 lb., *or* nitrate of soda ¼ lb. per year of tree age. Thus a 20-year-old tree in clean cultivation would need 4 lb. ammonium sulphate or cyanamid, *or* 2½ lb. ammonium nitrate, *or* 5 lb. nitrate of soda.

For unmulched sods the above amounts, in general, need to be doubled. For sod mulches the nitrogen requirement will depend upon the type of sod and of mulch.

Nitrogen equivalent table — The term "nitrate of soda or equivalent" is used frequently in the recommendations for fruit crops. Table 5 indicates the amounts of ammonium sulphate, cyanamid, and ammonium nitrate required in place of stated amounts of nitrate of soda.

TABLE 5. NITROGEN EQUIVALENTS

Nitrate of Soda 16% N	**Ammonium Sulphate 20% N**	**Cyanamid 20% N**	**Ammonium Nitrate 33.5% N**
100 lb.	80 lb.	80 lb.	48 lb.
200 lb.	160 lb.	160 lb.	96 lb.
250 lb.	200 lb.	200 lb.	120 lb.
300 lb.	240 lb.	240 lb.	144 lb.
400 lb.	320 lb.	320 lb.	192 lb.

Mineral fertilizers — Surface applications to cultivated orchards should be made either when the soil can be worked immediately or just prior to the planting of the green-manure crop, otherwise there will be considerable "fixation". See page 15. The green-manure crop will take up part of the minerals applied, to be later released by decomposition.

Deep placement of minerals is to be recommended for young orchards on low-mineral soils where it is desirable to quickly step up the mineral content at tree-root depth. In later years sod and green-manure crops, if properly maintained, should eventually release surface-applied fertilizers at tree-root depths. See page 27, and also consult Bulletin 457, Orchard Soil Management, for detail.

For fruit crops single-element materials are often used, as already indicated for nitrogen. Where either phosphate or potash is deficient, as shown by soil test, apply the deficient material in the amount needed. Or if both are low, use 0-12-20 at 300 to 500 pounds per acre.

Generally, 4-8-10 (or 5-10-13) has not been included in the tabular recommendations because nitrogen is best applied separately, and only when needed. However, for growers who desire a complete fertilizer, 4-8-10 (or 5-10-13) or a comparable analyses, is valuable as a "maintaining" fertilizer for orchards, whether cultivated or not, which are growing and fruiting normally and which are already known to be reasonably well supplied with minerals. Its mineral content is of particular value in stimulating growth of green-manure crops. However, for apple orchards, because of the nitrogen content, the application of 4-8-10 should be made in late fall or early spring, not delayed until June or July when the green-manure crop is planted and when the nitrogen would tend to delay fruit and tree maturity. Apply 600 pounds of 4-8-10 or 480 pounds of 5-10-13 per acre.

Sod and sod-mulch — In orchards, sod without a grass-smothering mulch under the trees should be treated approximately as cultivated land for manure and fertilizers, especially nitrogen. Such sods will, in fact, probably require even more nitrogen than cultivated orchards, especially with non-legume sods.

Also, even when properly mulched, it may take 3 to 4 years for the mulch to become effective in favourably modifying soil structure and releasing plantfood. If necessary during these years, treat the sod-mulch orchard much as a cultivated orchard, following the manure and fertilizer recommendations there given. Then proceed as recommended for sod-mulch orchards in Table 6, page 40.

Grapes

The grape soils of Ontario are mostly heavy and sufficiently fertile naturally for at least moderate growth and fruitfulness. In a 19-year experiment conducted by the Horticultural Experiment Station, Vineland, only organic matter returned an increase in crop yield sufficient to pay for the materials applied. This indicates the importance, especially where manure is not readily obtainable, of using hay and straw supplements and of encouraging the growth of green-manure crops by proper fertilization. Mineral fertilizers used to promote the growth of such crops will eventually be returned to the soil in a form believed to be suitable to the grape.

TABLE 6. RECOMMENDATIONS FOR FRUIT SOILS

NOTE—"N" = Nitrate of Soda or Equivalent. "GM" = Green Manure.

	Manure	Hay or Straw	Fertilizers	Nitrogen	Soil Management
CULTIVATED ORCHARDS, UN-MULCHED SOD ORCHARDS (see Text)	Either 10 tons manure annually in fall	Or 3 tons hay or straw* annually in fall, with 150 lbs. N. Add another 150 lbs. N. in the spring.	200 Superphosphate and 125 Potash or 300 0-12-20 With G.M. crop or on sod (4-8-10, 5-10-13, see Text)	In late fall, or spring, am't based on tree age, (see Text-'NITROGEN')	If Cultivated stop before June 15. Plant a G.M. crop. If Sod Mow as required.
SOD MULCH ORCHARDS	None needed where a proper mulch is maintained (see Text)	Mulch under trees with cover grown and cut in orchard, with additional old hay, straw, etc., if needed.	Apply mineral fertilizers, if needed, and in amounts indicated by soil tests.	As needed. In late fall, or spring, am't based on tree age. (see Text)	Mow as required and place material under trees.
GRAPE	Either 10 tons manure at least every other year	Or 3 tons hay or straw* in fall at least every other year, with 150 lbs. N. and 250 lbs. 0-12-20 Trash disk. Add another 150 lbs. N. in the spring.	250 0-12-20 annually with G.M. crop	Only as a supplement to non-legume hay or straw.	Stop cultivation about June 15, and plant a G.M. crop.
STRAWBERRY	Year previous to planting Either 20 tons manure in spring	Year previous to planting Or 6 tons hay or straw* in spring, with 300 lbs. N. Add another 300 lbs. N. in the fall.	Year previous to planting 400 Superphosphate and 200 Potash or 600 0-12-20 With G.M. crop	After planting Side dress with 150 lbs. N. after plants have become well established.‡	Season previous to planting. Grow a G.M. crop.
RASPBERRY	Year previous to planting Either 20 tons manure in spring	Year previous to planting Or 6 tons hay or straw* in spring, with 300 lbs. N. Add another 300 lbs. N. in the fall.	Year previous to planting 400 Superphosphate and 200 Potash or 600 0-12-20 With G.M. crop	Only as a supplement to non-legume hay or straw.	Season previous to planting. Grow a G.M. crop.
	Thereafter Either 10 tons manure annually	Thereafter Or 3 tons hay or straw* annually in fall, with 150 lbs. N. Add another 150 lbs. N. in the spring.	600 - 800, 4-8-10 or 480 - 640, 5-10-13	Only as a supplement to non-legume hay or straw.	Each year after fruiting time, plant a G.M. crop.
CURRANT and GOOSEBERRY	Either 10 tons manure annually	Or 3 tons hay or straw* annually in fall, with 150 lbs. N. Add another 150 lbs. N. in the spring.	600 - 800, 4-8-10 or 480 - 640, 5-10-13	Only as a supplement to non-legume hay or straw.	Each year after fruiting time, plant a G.M. crop.
	As a complete alternative to the above for currants and gooseberries, maintain a legume mulch over the entire plantation. Use such materials as alfalfa threshings.		No nitrogen* supplement is necessary. Maintain at 4 to 6 inch depth by annual additions. While expensive, this method has been demonstrated to be commercially feasible.		

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* If legume materials are used the nitrogen supplement is unnecessary.

‡ Repeat after fruiting if patch is to be fruited a second year.

Small Fruits

For small fruits, soils high in organic matter are a practical necessity. These fruits are heavy feeders having regard to comparatively shallow rooting, short season from bloom to harvest, and heavy weight of crop in proportion to plant; thus they need plenty of readily-available food plus ample moisture. Farm manure is undoubtedly the best basic material, with additional nitrogen and minerals where the need is shown.

Currants and gooseberries do well when mulched. A considerable part of the benefit is from the cool, moist condition under the mulch throughout the summer months. However, the maintaining of an adequate mulch for these small fruits may be a considerable undertaking. One large grower who has adopted a mulch system states — "Mulching gooseberries requires at least 50 large truck-loads of alfalfa threshings per acre annually to maintain a 4-inch depth. Less will not keep down the weeds, and yet it is so much that the cultivator clogs up."

At Vineland, *raspberries* have responded particularly to potash, on soils known to be low in this element. Generally, the lighter small-fruit soils in southern Ontario are likely to be low in potash.

The *strawberry* soil needs considerable preliminary preparation, especially if it is an "old" soil. The need is for a high build-up of organic matter, plus freedom from weeds. This involves manuring a year in advance of planting, and growing a weed-smothering green-manure crop. Virgin, or recently broken land, needs less advance preparation.

Strawberries prefer, or at least are tolerant of acid-reaction soils. Definitely alkaline soils are injurious. This indicates the desirability of using fertilizers tending to an acid reaction, though ammonium sulphate may not be applied on top of the foliage, when renewing a patch for a second fruiting year, because of risk of burning.

Vegetables

General considerations — High production, improved quality, and maintenance of soil fertility are the primary aims of the vegetable grower. The importance of higher-quality vegetables is increasingly recognized inasmuch as the health and vigour of the population is influenced by mineral and vitamin content.

Unless soils are in good physical condition, plants cannot make satisfactory growth, nor will added fertilizers give their best response. Growers are advised to read carefully Soil Sense, pages 7 to 23 on organic matter, lime, manure, drainage and tillage.

Drainage — Good drainage is of vital importance to high production. Surface drainage in most cases is not enough. See page 7, Aeration and Drainage.

Organic matter — The text on page 8 of this publication deals with the importance of organic matter for all crops. The increased cultivation which vegetables receive oxidizes or burns out the organic matter very rapidly, and where irrigation is practised there is a further loss of organic matter. Green-manure crops and cover crops should be used whenever the land is idle for any length of time.

FIG. 16. The intensive cultivation and cropping practices of truck farming require heavy annual applications of manure (or other organic matter) and fertilizer to replace plantfood losses, if yield and quality are to be maintained.

Liming — Attention is often drawn to soil reaction, or pH (see page 20), without stressing that the calcium (lime) used to correct excess acidity is also one of the essential plant foods. (See page 17, Lime.)

Minor elements — Minor elements should be applied only on expert advice or where experience has proven their application to be necessary.

Boron — A lack of boron may cause "cat-scratches" on celery; cracking or drought-spot of root crops; internal breakdown of beets, cauliflower, and turnips. As boron is needed in only very small quantities, and since an over-dose will prove toxic, extreme care should be taken in its use. Continued application should not be made unless on expert advice.

Copper — A lack of copper may cause "rabbit-ear" in lettuce; poor colour and keeping quality in onions; poor quality in carrots. As in the case of boron, this minor element must be used with care.

Manganese — There has been some evidence of manganese deficiency in some crops. The general symptoms are "rosetting" of beets, and a yellowing of carrots and onions. Spray applications of ten pounds of manganese sulphate to 100 gallons of water have proven more effective than direct soil applications.

The Importance of soil testing — Correct balance of fertility is very important in commercial vegetable growing. The very intensive cultivation program necessary for continuous high yields calls for a thorough understanding of how to maintain organic matter and nutrient levels. (See page 20, Nutrient Balance.)

Transplanting and booster solutions — Liquid fertilizer solutions have proved of value when applied to the flats 3 to 4 days before transplanting, at transplanting time, and as a booster some time after transplanting, or in case of a check from drouth or other causes. (See page 27, Fertilizers Used in Solution.)

Green-manure crops — After harvesting the *early* vegetable crop, plant a green-manure crop. The following are suggested, varying with conditions. Generally the rates recommended are minimum.

1. Winter rye at 2 bu. or rye and oats at 1½ bu. each.
2. Domestic or Italian rye grass at 20 lb. per acre.
3. Soybeans at 2 bu. per acre, inoculated with a suitable culture and treated with Spergon or Arasan seed disinfectant.
4. A soil difficult to work is better taken out of cultivation for a year and planted to sweet clover at 30 lbs. per acre.
5. Where irrigation is available, or there is an abundance of soil moisture, Sudan grass may be sown at 30 lb. per acre.
6. When no early vegetable crop is planted use a green-manure crop. A mixture of peas (1 bu.) and oats (2½ bu.) is recommended. Sow this mixture as early as possible in the spring.

Whenever a green-manure crop is used and no subsequent winter cover crop planted, it is best to let the green-manure crop stand over winter. Before trash disking (see page 13) and plowing in the spring (at least two weeks before planting) broadcast the fertilizer planned for the vegetable crop.

Cover crops — Following the *late* vegetable crops an over-wintering cover-crop should be sown. The most effective crops for this purpose are:

1. Winter rye at 3 bu. per acre.
2. Domestic or Italian rye grass at 20 lb. per acre.
3. If a small-seeded spring vegetable crop is contemplated do not use rye, as the heavy straw will make seeding difficult. Instead, plant either spring wheat or oats at 2 bu. per acre. These crops will be killed by the frost and not cause any difficulty in seeding next spring.

Recommendations, market garden crops — The soils preferred are of the lighter types (sandy loams and silt loams), must be well drained, and should receive annual applications of organic matter and fertilizer to maintain high production. There will be occasions when the land is to remain idle for a short period of 4 to 6 weeks. Rather than leave this land bare, seed a green-manure crop, turning under when it is time to sow the next vegetable crop. Where this may not be feasible owing to rapid succession of crops, large amounts of manure must be applied. A periodic check of fertility levels should be maintained by soil tests.

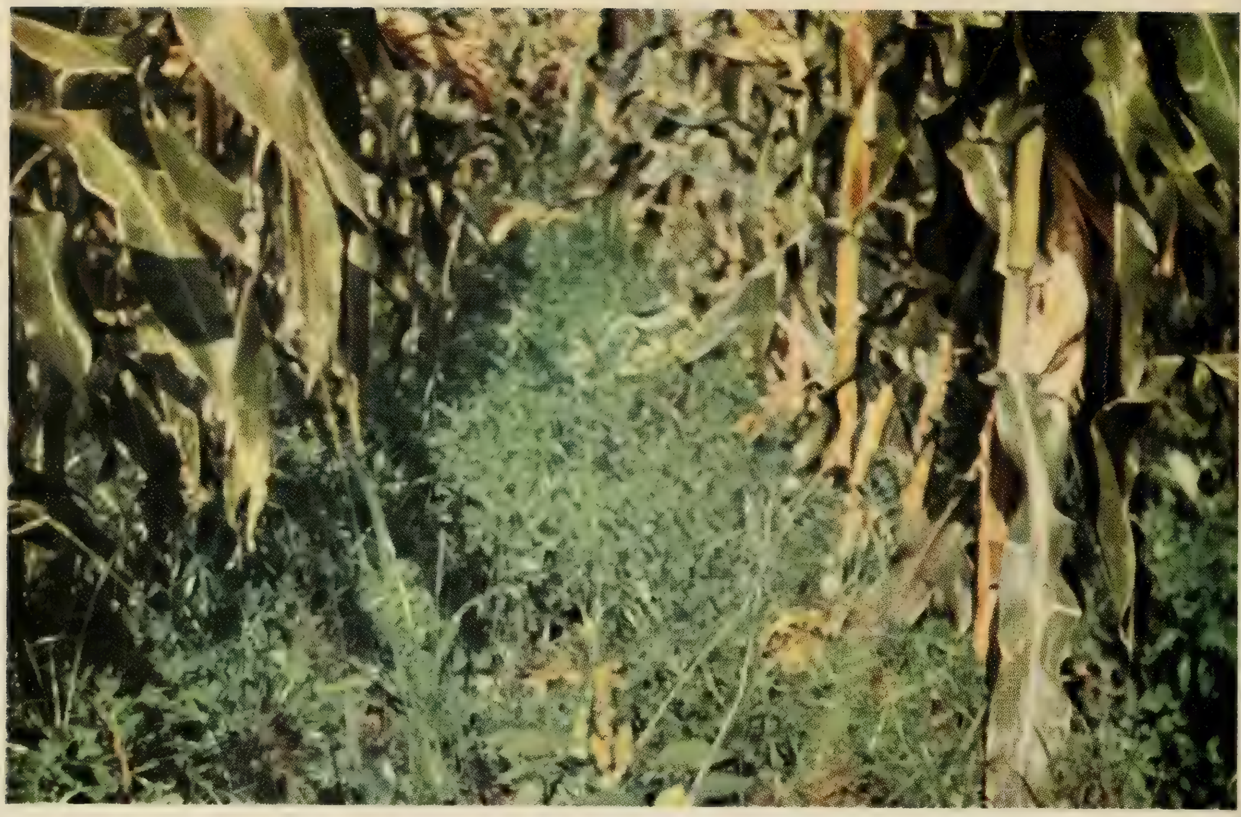

FIG. 17. Maintenance of soil fertility for future crops is aided by such practices as seeding-down corn with a legume crop at the time of the last cultivation.

TABLE 7.
GENERAL RECOMMENDATIONS FOR MARKET GARDEN CROPS (1)

Crop	Rate per Acre in Pounds and Analysis			
	Light Soils		Heavy Soils	
	5-10-13 or 4-8-10		5-10-13 or 4-8-10	
Asparagus (2)	1600	2000	1200	1500
Beans (3) (8)	400	500	400	500
Beets	800	1000	600	750
Cabbage (4)	800	1000	600	750
Carrots	800	1000	800	1000
Cauliflower (4)	800	1000	800	1000
Celery (4)	800	1000	800	1000
Chard	800	1000	800	1000
Corn, Sweet (8)	800	1000	800	1000
Cucumbers	800	1000	800	1000
Early Potatoes	960	1200	800	1000
Late Potatoes	1200	1500	800	1000
Lettuce	800	1000	600	750
Melons	800	1000	800	1000
Onions (5)	800	1000	800	1000
Parsnips	800	1000	600	750
Pumpkins	800	1000	800	1000
Spinach (6)	800	1000	800	1000
Squash	800	1000	800	1000
Eggplant	1000	2-12-10	1000	2-12-10
Peas (3) (8)	500	2-12-10	500	2-12-10
Peppers	1000	2-12-10	1000	2-12-10
Tomatoes (7) (8)	1000	2-12-10	1000	2-12-10

NOTE—The special needs of individual crops are discussed under reference numbers as indicated.

1. These recommendations are general only. Supplementary side-dressings of nitrogen and potash may be applied as required. Where higher analysis fertilizers of the same ratio can be secured their use is recommended at proportionately lower rates.

2. Asparagus. A good start is given the new bed by sowing 1500 pounds 2-12-10 per acre in the bottom of the trenches before planting. Cover the fertilizer with some soil before setting the plants. Cyanamid, preferably the pulverized form, may be used to control broad-leafed annual weeds in the established planting. Apply twice a year — once during the cutting season and again at the end. Treatment is made in a band about 18 inches wide directly over the row when the weeds are not more than 1 inch high. Apply when dew is present, and there is prospect that a bright, hot day will follow. A maximum of 100 pounds per acre per season is recommended, as excessive amounts of nitrogenous fertilizer may adversely affect the keeping quality of the asparagus. The use of a duster will facilitate light, even applications.

3. Beans, peas. Do not sow fertilizer in direct contact with these seeds as injury may result.

4. Cabbage, cauliflower, celery. These crops respond to side-dressings of nitrogen and potash supplementary to the regular fertilizer application. Where crop experience has shown, or the need for boron is clear, particularly on celery, apply borax. (See page 42, Minor Elements.)

5. Onions. Side-dress with nitrogen or potash as required.

6. Spinach. Side-dress with nitrogen to maintain rapid, continuous growth.

7. Staked and early tomatoes. Side-dress where necessary with nitrogen and potash at the time of the last cultivation.

8. Where tomatoes, corn, peas, and beans are grown for canning purposes see specific recommendations under "Canning Crops", page 47.

Recommendations, muck soil crops — Virgin muck soils are characterized by low levels of phosphate and potash, and varying lime content. The total nitrogen contained in the organic matter of muck soils is high but in most cases is not readily available. The amount of additional nitrogen needed to grow any given crop can best be determined by a soil test, appearance of the crop, and past experience.

Since, therefore, muck areas vary so greatly in their composition and fertilizer needs, each should receive individual treatment based on experience, experimental evidence, and soil test.

Also, because of the physical characteristics of muck soils, the longer and more intensively they are cultivated and fertilized, the more important it is that choice of fertilizers be based on soil analysis. Because of the peculiar water relationship of muck soils, fertilizers should be placed 2 to 4 inches below the surface, either by grain-drill application or by disking.

Recent experimental work indicates that the fertilizer requirements of the Bradford marsh are somewhat different to those of other muck soil areas. Therefore the Bradford recommendations are given separately in Table 8.

Table 8. General Recommendations for Muck Soil Crops

	Analysis and Rate per Acre in Pounds (1)			
	Recently Cleared (2)		**In Cultivation 10 Years or More (3)**	
General	**Rate**	**Analysis**	**Rate**	**Analysis**
Beets	1000	2- 8-16	1500	4- 8-10
			or 1200	5-10-13
Cabbage	1000	2- 8-16	1500	2- 8-16
Carrots	1000	2- 8-16	1500	2- 8-16
Cauliflower	1000	2- 8-16	1500	2- 8-16
Celery	1500	2- 8-16	2000	2- 8-16
Onions	1500	2- 8-16	2000	2- 8-16
		or 0-12-20		**or** 0-12-20
Parsnips	1000	2- 8-16	1500	4- 8-10
			or 1200	5-10-13
Potatoes	750	2- 8-16	1250	2- 8-16
Spinach	750	2- 8-16	1000	2- 8-16
Bradford				
Beets	1000-1200	2-12-16	1000	2-12-16
Carrots	1000-1200	2-12-16	1000	2-12-16
Celery	1000-1500	3-12-16	1200-1500	2-12-16
Lettuce	750-1000	3-12-16	750	2-12-16
Onions	1000-1200	2-12-16	750-1000	0-12-20
Parsnips	1000-1200	2-12-16	1000	2-12-16
Potatoes	1000-1200	2-12-16	1000	2-12-16
Spinach	750-1000	3-12-16	750	2-12-16

1. In addition to the amounts specified, see the notes for the crops listed below. Also see page 42, Minor Elements.

Celery — Copper and boron should be added as required. On new soils add 100 pounds copper sulphate and 40 pounds borax per ton of fertilizer. On the older soils add 40 pounds borax per ton of fertilizer. Sufficient copper on the older soils is usually added where copper fungicides are used as dusts. Side-dressings of nitrogen and potash should be applied as needed.

Lettuce, Onions — On the newer soils and for the first three to five years, add 100 pounds copper sulphate and 40 pounds borax per ton of fertilizer used. After this 3- to 5-year-period use copper sulphate and borax only on the basis of experience and experimental evidence.

Carrots, Potatoes — Add 50 pounds copper sulphate and 40 pounds borax per ton of fertilizer used. This application is not necessary if these crops follow celery, lettuce or onions which have already had copper sulphate and borax applications as noted above.

2. Recently cleared — Most of the Bradford and Holland marsh and any new marsh development.

3. In cultivation 10 years or more — The older areas of the Bradford and Holland marsh, Erieau, Thedford, and similar areas.

Canning Crops

Before studying the following section, readers are urged to become familiar with the information contained in the section, Soil Sense, pages 7 to 23.

The canning crops referred to below are usually grown as cash crops on general farms. Their growth and yield will be improved if they are grown in a rotation which includes hay and pasture crops, green-manure crops, supplemented with commercial fertilizers and farm manure. Except as noted in the case of tomatoes these organic matter crops should immediately precede the canning crop and should be trash-disked and plowed while still succulent, just prior to the normal time for cutting the second hay crop.

If the sod crop is not a legume, broadcast 100 to 150 pounds of ammonium nitrate per acre, or its equivalent (see Table 5, page 38), just before plowing. Manure may be spread during the winter or early spring, but for best results apply just prior to plowing down the sod. When sod land is plowed in late summer or early fall it should not be left bare over winter. A fertilized cover crop sown at this time will utilize and hold nutrients, reduce soil erosion, and contribute organic matter.

Soils for canning crops — Beans. Silt and clay-loam soils, where either a crop of clover, or clover and grass, has been turned under. Reasonably level land of uniform texture will assist in obtaining uniform maturity.

Corn. Medium to heavy loam soils are best. Well-manured sod plowed either in the fall or just previous to the normal time of cutting the second hay crop is recommended.

Peas. Level, well-drained, clay-loam soils of uniform texture, with a clover, or clover and grass, sod preceding the crop.

Tomatoes. Well-drained clay-loam soils plowed the fall previous to planting. On the heavier soils it may be desirable to plant tomatoes the second year after sod to avoid excessive late growth. Soils lower than pH 6.0 should receive one-half ton of ground limestone per acre.

Fertilizer recommendations — Beans. Apply 500 to 700 pounds 4-8-10 per acre, or 20 percent less of 5-10-13. To avoid injury to the young plants do not sow the fertilizer with the seed; close off the tubes sowing seed, allowing it to flow through the remaining tubes.

Corn. Apply 500 to 750 pounds 4-8-10 per acre, or 20 percent less of 5-10-13. Apply with a fertilizer drill allowing all tubes to sow fertilizer. Where growers use corn planters with fertilizer attachments, approximately one-quarter of the above application should be retained for application through the planter attachment.

Side-dress with fertilizer when the sweet corn is about 12 to 14 inches high. Use a complete fertilizer such as 4-12-6 at 150 pounds per acre.

Peas. To avoid injury to the seed it is recommended that the fertilizer be applied a few days previous to planting. Use 300 to 500 pounds 2-12-10 per acre, or where more nitrogen is required, 300 to 500 pounds 4-12-10 per acre. There is evidence that under some soil conditions

FIG. 18. A good clean lawn improves any home. Its maintenance should include annual fertilizing.

both yield and quality may be improved by an application of 100 pounds of ammonium nitrate (or equivalent) per acre in addition to the recommended application of complete fertilizer.

Pea seed should be inoculated to encourage nodular formations on the roots, especially when sown on land that has not grown peas previously. Use a *fresh* humus, or a pure type, culture and sow within 2 to 3 hours after inoculating the seed.

Tomatoes. When setting out tomato plants use a transplanting solution (see page 27, Fertilizers Used in Solution).

In addition to manure add 750 to 1000 pounds 2-12-10 plus 400 pounds of superphosphate per acre. Apply all of the superphosphate and about three-quarters of the complete fertilizer as deeply as possible by use of a grain and fertilizer drill, by deep placement, or by broadcast before plowing. Apply the remaining quarter with the tomato planter. Nitrogen analyses higher than 2 percent are not recommended except on the basis of a soil test, owing to the danger of late maturity and blight.

To prevent fall starvation and to insure proper ripening of the crop side-dress at the time of the last cultivation with approximately 100 pounds per acre of muriate of potash. An additional application of 100 pounds ammonium nitrate per acre may be applied at the same time where poor growth or excessive rainfall indicate a need.

Turf and Lawn

A good clean lawn commands attention and gives pride to the owner but cannot be obtained without painstaking, constant care.

To establish a satisfactory turf the soil must be in good physical condition, graded to an even surface, and planted to suitably adapted grass species. Subsequent treatment involves proper cutting, fertilizing, and weed control.

Cutting — Do not clip close during the hot, dry periods of midsummer. Raise the cutting bar of the lawn mower about one inch.

Fertilizing — Probably the most common cause of poor turf is lack of sufficient plantfood, especially nitrogen, since active turf is continually producing new growth. Of the minerals, phosphorus is the most important, except on the often potash-deficient sandy and muck soils. Minor elements can be supplied from inorganic materials.

Just before seeding, lightly rake in 15 pounds of 20 percent superphosphate per 1000 square feet of lawn surface.

Subsequent maintenance operations should be designed to promote a slowly growing, dense, healthy, weed-free condition. A rapid, luxuriant growth is not necessary, and is definitely undesirable during the warmer months because succulent growth is more susceptible to disease and drought.

Where the soil has become compacted it may be loosened with a spike disk. As well as improving soil structure and water-holding capacity, this loosening and aerating permits of the ready downward movement of applied plantfood to the root area.

Under average conditions make fertilizer applications to established turf once in the early spring, and again in the fall. Use a 10-6-4 lawn fertilizer containing 25 percent of its nitrogen from organic materials. Other garden fertilizers are satisfactory also. Apply 8 to 10 pounds per 1000 square feet.

Spread the fertilizer evenly. If a mechanical spreader is used, avoid overlapping, leaving unfertilized strips, or spilling at starting and finishing points. Apply when the grass is dry, and water-in immediately to avoid fertilizer burn.

A liberal dressing of farm manure may be applied in the late fall. *Use only well-rotted manure* so that it will be free of viable weed seeds. It should be finely divided with no large lumps allowed to lie on the grass. In the early spring rake off any remaining coarse portions.

Weeds — Most weeds may now be effectively controlled with chemical sprays, such as 2 4-D, without permanent damage to the turf. The proper use of these chemicals is discussed in various government publications including Ontario Bulletin 448, Lawns. Once weeds have been eliminated, follow up with fertilizer and, in some instances, top-dress with compost and add more seed.

Insects and Diseases — Consult Ontario Bulletin 448, Lawns.

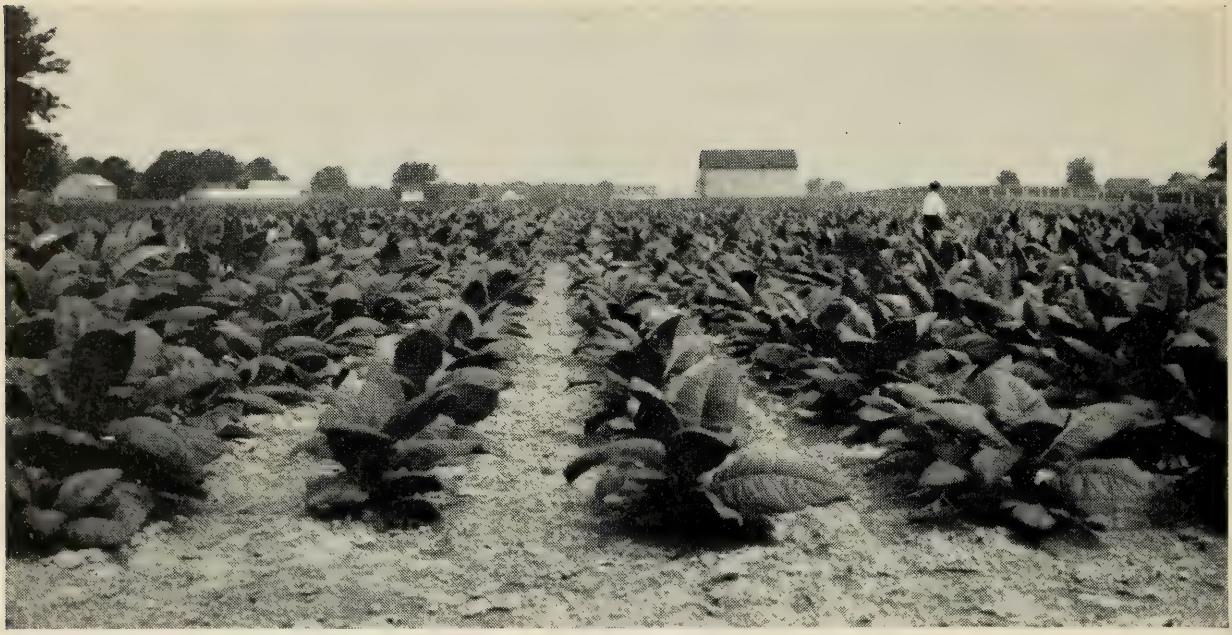

FIG. 19. The management of tobacco soils requires very watchful attention to organic matter, and the use of specially compounded fertilizers in carefully determined amounts. In the above illustration the two centre rows were not fertilized.

Tobacco

General Considerations — Organic matter in some form is vitally important as, besides its normal values in crop production (see page 8), it reduces wind and water erosion of the light tobacco soils. Winter cover-crops and rest crops provide organic matter, reduce leaching of plant nutrients, and check erosion.

Fertilization of green-manure and cover crops, and the use of nitrogen on crop residues, assists in maintaining organic matter. Ammonium nitrate (125 pounds) or cyanamid (200 pounds), applied when disking-in a mature crop of rye will reduce the need for farm manure, and improves subsequent tobacco crops. Where the soil is low in minerals a complete fertilizer should be used instead of nitrogen only.

Fertilizer, for the tobacco crop, supplements and balances the plant-food in active organic matter, whether supplied as green-manure crops or as farm manure. Efficient use of fertilizer is influenced by the amount and type of organic matter present, soil type, manure applications, cultural methods, and by the incidence of disease. These factors should be considered in determining the fertilizer analysis to use for tobacco, and the rate of application.

Methods of application — The fertilizer is best applied at transplanting time in bands about four inches on each side of the row, and on a level with, or slightly below, the root crown (three to four inches deep). However, if the application is made in the row before planting, it should be thoroughly mixed with the soil a week before transplanting in order to avoid fertilizer burn. If the fertilizer for burley is applied with a grain-drill attachment it should be drilled in 3 to 4 inches deep. Broadcasting and disking is wasteful of material, and not recommended.

Sources of plant nutrient materials — Special attention is required in choosing materials for making commercial fertilizer for tobacco. Results of experiments indicate an advantage in using more than one source of nitrogen. Approximately one-half of one percent of the total nitrogen should be in the form of nitrate. The potash may be supplied in the form of sulphate of potash, or a combination of sulphate and muriate of potash. While a portion of the potash may be supplied from water-soluble sources other than sulphate of potash, the chlorine content of the fertilizer should not be more than 3 percent, nor less than 2 percent. To prevent magnesium deficiency, it is recommended that a high-grade dolomitic limestone analysing at least 19 percent magnesia (MgO) be used as a filler in tobacco fertilizers.

Fertilizer for the seedbed — One bag of tobacco fertilizer containing 2 to 3 percent nitrogen to 1000 square feet of bed and mixed with the muck before seeding, has given good results. Under ordinary circumstances, when this application is made, no additional fertilizers are required in the seedbed.

Starter or transplanting solutions — So-called "starter solutions" used in the transplanter barrel have failed to improve the flue-cured tobacco crop in tests conducted over a period of years. In fact, they have frequently been harmful, causing fertilizer burn.

Flue-cured tobacco—Under ordinary conditions, 800 to 1000 pounds per acre of fertilizer furnishes the required amount of plantfood. Where more than 1000 pounds is required for best quality and yield, a faulty cropping system is indicated. A 2-10-8 fertilizer is recommended for average conditions, including land where yield and maturity have been satisfactory. A 2-12-10, applied at a slightly lower rate, gives a better balance of plantfood on soils having a fairly high natural organic-nitrogen content. A 3-10-8 mixture may be used to obtain greater size of leaf on some of the lighter soils that have been intensively cropped with tobacco. However, the need for additional nitrogen indicates that the soil organic-matter has been partially depleted and should be corrected.

Burley tobacco — Burley tobacco soils in Ontario vary a great deal in type and fertility; the fertilizer analysis, therefore, should be chosen to suit the circumstances.

Burley tobacco responds readily to liberal supplies of active organic-matter. Applications of manure, the use of crop residues, and the inclusion of soil-building crops are recommended.

Under ordinary conditions, the additional plantfood needed will be supplied by 500 to 1000 pounds per acre of commercial fertilizer. For sandy-loam and gravelly-loam soils use 4-8-10 at 500 to 1000 pounds per acre, or 20 percent less of 5-10-13. On fertile dark-loam and clay-loam soils use 2-12-10 or 3-10-8 at 500 to 1000 pounds per acre.

Dark tobacco — The proper maintenance of soil organic-matter is essential to provide suitable body, elasticity, and dark brown colour desirable in good quality wrapper leaf. In addition to manure or other organic-matter, and under average conditions, apply 500 to 1000 pounds of 4-8-10 per acre, or 20 percent less of 5-10-13. When heavy applications of farm manure are plowed under with alfalfa or sweet clover, a 3-10-8 may be found to mature the tobacco to better advantage, particularly on the heavier clay-loam soils.

TERMS FREQUENTLY USED IN FERTILIZER WORK

B	Boron, Borax ($Na_2B_4O_7$), Boric Acid (H_3BO_3).
Ca	Calcium, the basis of lime.
$CaCN_2$	Cyanamid, 20% N. and 70% Ca.
$CaCO_3$	Calcium carbonate, Agricultural lime, Air-slaked lime.
$CaCO_3 . MgCO_3$	Dolomitic limestone.
CaO	Calcium oxide, Quicklime.
$Ca(OH)_2$	Hydrated lime.
$CaSO_4$	Calcium sulphate, Gypsum, Landplaster.
Cu	Copper.
$CuSO_4$	Copper sulphate, Bluestone.
Fe	Iron.
$FeSO_4$	Iron sulphate, Ferrous sulphate, Copperas.
K	Potassium.
KCl	Potassium chloride, Muriate of potash, 50 and 60% K_2O.
K_2CO_3	Potassium carbonate, a constituent of wood ashes.
KNO_3	Potassium nitrate, Saltpetre, 14% N. and 45% K_2O.
K_2O	Potassium oxide, the "Potash" of fertilizers.
K_2SO_4	Potassium sulphate, 48% K_2O.
Mg	Magnesium.
$MgCO_3$	Magnesium carbonate, constituent of dolomitic limestone.
MgO	Magnesium oxide, Magnesia.
$MgSO_4$	Magnesium sulphate (Epsom salts).
$MgSO_4 . K_2SO_4$	Sulphate of potash magnesia, Sulpho-Mag.
Mn	Manganese.
$MnSO_4$	Manganese sulphate.
N	Nitrogen.
Na	Sodium.
$NaNO_3$	Sodium nitrate, Nitrate of soda, 16% N.
NH_3	Ammonia.
NH_4NO_3	Ammonium nitrate (Nitraprills), (Aeroprills), 33.5% N.
$(NH_4)_2SO_4$	Ammonium sulphate, 20% N.
NO_3	Nitrate.
P	Phosphorus.
P_2O_5	Phosphorus pentoxide, "Phosphoric acid" of fertilizers.
S	Sulphur.
Zn	Zinc.

AMMONIUM PHOSPHATE — A mixture of ammoniated superphosphate and ammonium sulphate, 11% N. and 48% P_2O_5.

DOLOMITIC LIMESTONE — An agricultural limestone or ground limestone, containing both magnesium carbonate and calcium carbonate.

SUPERPHOSPHATE — Ground rock phosphate treated with sulphuric acid, 20% P_2O_5. Triple superphosphate, 38 to 47% P_2O_5.

BURN — Fertilizer burn, sand burn, usually dead foliage areas due to the use of the wrong fertilizer or too much fertilizer.

MINERALS — In this publication usually refers to phosphate and potash. Calcium is a mineral. Minor elements such as boron, copper, sulphur, are also minerals. Nitrogen is not a mineral.

SOIL ACIDITY — pH of soils, see page 20.

TOXIC — Poisonous, stops growth of plants.

NOTE — Fertilizer analyses are stated thus: 2-12-10, 0-12-20. The first number in each analysis represents the percentage of total nitrogen (N); the second represents the percentage of available phosphoric acid (P_2O_5); and the third represents the percentage of available potash (K_2O).

THE FERTILIZERS ACT

Administered by the

DOMINION DEPARTMENT OF AGRICULTURE. OTTAWA.

SECTION 4.

"(1) No person shall manufacture, import or advertise any fertilizer for sale in Canada, unless each brand is first registered with the Minister and a registration number assigned to it."

SECTION 6.

"(f) When a claim is made for any plantfood substance or element in a fertilizer, or other substance for any purpose, in addition to Nitrogen, Phosphoric Acid, or Potash, the name of such substance or element and its quantity in the fertilizer, expressed in pounds per ton, shall be marked on the package containing the fertilizer or label attached thereto — Provided that in the case of boron, such marking shall include additionally the phrase:

CAUTION: This fertilizer contains borax and should be used on crops only when recommended by a competent authority. Borax may prove harmful to some crops when misused."

Inquiry as to the application of The Fertilizers Act should be made to the Plant Products Division, Production Service, Department of Agriculture, Ottawa.

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Cir. 68 Guide to Crop Production in Ontario (1947).

Bul. 407 Soybeans in Ontario (1940).

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Pub. 715 Flue-Cured Tobacco Growing in Ontario (Dom. Dept. Agr., 1946).

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FRUIT CROPS

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Bul. 433 Establishing the Young Orchard (Revised 1947).

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Bul. 440 Currants and Gooseberries (Revised 1948).

Bul. 458 The Strawberry in Ontario (1948).

SOILS AND FERTILIZERS

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Pub. 802 Orchard Soil Management and Apple Nutrition (Dom. Dept. Agr., 1948

Hunger Signs in Crops (Am. Soc. of Agron. and Nat. Fert. Assoc., 1941

For all Circulars and Bulletins listed above write to:

Statistics and Publications Branch,
Department of Agriculture,
Parliament Buildings,
Toronto, Ontario.

For Publications (703, 715, 808, 585, 802) write to:

Publicity and Extension Division,
Department of Agriculture,
Ottawa, Ontario.

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